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UNDERSTANDING PATENT SYSTEM THROUGH THE ANALYSES OF PATENT FLOWS ACROSS COUNTRIES AND OF PATENT QUALITY

DOCTORAL DISSERTATION

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EXECUTIVE SUMMARY

Chapter 1: Introduction

This dissertation aims at improving the knowledge of the patent system in respect of two of the key issues which are currently debated in almost all the advanced economies and which are often strategically valuable elements in many emerging countries: the harmonisation of the patent procedures among world patent authorities and the quality of the offered patent services. Such issues will be respectively analysed in detail for two patent offices (POs), the Japan Patent Office (JPO) and the European Patent Office (EPO).

The relevance of patents extended to foreign countries is rising for different stakeholders. The world largest patent offices have already launched several initiatives, such as the Foundation Project in the "Five IP Offices" Project or the several bilateral agreements called "Patent Prosecution Highways". The harmonisation of procedures, which deals with the internationality of the received patent applications in a certain PO, will be first investigated through the data of the JPO (Chapters 2 and 3); then a similar analysis will be extended to other relevant POs (Chapter 4). A better understanding of the dynamics of the international extensions would improve the patent system.

The quality of the patenting procedure will be examined both from the point of view of the users' perceived quality and with an econometrical approach by analysing data on opposition inherent to the EPO. Such study will be presented in Chapter 5

Chapter 2: Overview of the Japanese Patent System

In this Chapter, we describe the most relevant changes in the development of the Japan's IP system: historical events and key characteristics of the Japanese patent system, such as the first-to-file rule, the limited number of claims or the main recent amendments, are examined.

The JPO is one of the three most relevant offices in the world, together with the United States Patent and Trademark Office (USPTO) and the EPO, in terms of number of patent applications and grants. The JPO has faced many changes because of the several amendments in the national IP policy especially from the 1990's and even much more since 2002 when Japan clearly decided to focus on creating an "IP-based nation". Under an historical point of view its IP system development could be divided in three stages: i) birth of the IP system (until 1950), ii) reconstruction and catch-up phase after World War II (until 2000) and iii) creation of an IP-based nation, process started in 2000 and not yet completed.

The post-war Japanese patent system was originally established in the 19th Century not only to encourage domestic inventors, but to facilitate technology transfer from the West: it has been described as a mechanism for promoting both "diffusion and exclusion" (Ordover, 1991; Granstrand, 1999; Cohen et al., 2002). It contributed positively to productivity growth, to the extent that it enhanced diffusion of technical knowledge through the Japanese economy and generated useful adaptive inventions.

The core element of the final phase in the development of the Japanese IP system is the Basic Law on IP (2002). With it, Japan clearly identifies IP system as a key point to realize a "sound development of the national economy", the "creation of a rich culture", the "intensification of the international competitiveness" and a "sustainable development of Japanese industry". The central point of the Basic Law is the promotion of a program for the development of an IP virtuous cycle: from "creation" (filing of patents, trademarks, utility models…), to "protection" (issue of IPRs), to "exploitation" (profiting from IPRs) and to "creation" again (trough re-investment of profits).

Chapter 3: Foreign Applications at the Japan Patent Office – An empirical analysis of selected growth factors

This Chapter aims to evaluate some of the possible factors which could have had a significant role in the increase in the yearly number of foreign patent applications at the JPO. The analysed period ranges from 1991 to 2005: in such years, foreign applications increased constantly while the number of domestic filings remained almost the same or even decreased. The increase is more striking when compared to analogue figures for the USPTO and the EPO, where the corresponding ratio didn't change too much in the same period.

Building on previous literature, this study analyses the impact of some macroeconomic and structural characteristics of the extending countries, on one side, and, on the other side, some features specific to the receiving country and its Patent Office (here Japan and the JPO). This work tries to capture the relevance of such drivers in the increased amount of foreign patent applications at the JPO.

The analyses on the data collected from the JPO Annual Reports are performed by taking into account the drivers recognized by the existing literature. The regression results suggest that the growth in international filings at the JPO is positively related to the innovative capabilities of the extending (originating) countries and to the international harmonisation of the patent systems. Additional controls are carried out by verifying the influence of China and the presence of industry specificities.

Chapter 4: International Patent activities: Patent Export from Europe, USA, Japan, China, South Korea, India, Brazil, Mexico and Russia

The Chapter extends the results of the previous one by analysing exported patent data and investigating possible reasons behind tighter or looser exchange relationships among countries. Regression analyses about the magnitude and the trend in patent flows from and to nine of the major worldwide patent organisations are carried out. The involved POs are: the EPO, the USPTO, the JPO, the Chinese State Intellectual Property Office (SIPO), the Korean Intellectual Patent Office (KIPO), the Office of the Controller General of Patents, Designs & Trade Marks of

India (CGPDTM), the "Instituto Nacional da Propriedade Industrial" for Brazil (INPI), the Mexican Institute of Industrial Property (IMPI) and the Federal service on intellectual property, patent and trademarks, (Rospatent) for Russian Federation.

The analysed records have been extracted from the EPODOC database. In order to define flows from one country to another, the nation of origin has been identified by using the priority countries, since applicants' nationalities were not widely available for all the involved POs.

Regression results confirm the relevance of some of the macroeconomic drivers (such as the GDP per capita and the export of goods) while no significant conclusion is found for factors such as FDI and population even if such outcome has to be evaluated by taking into consideration the particular sample of countries.

The variables describing the harmonization of the patent systems and the membership in international treaties report significant coefficients and suggest that the more similar the patent protection between two countries, the larger the flow of extended patents between them.

Chapter 5: Patent quality: An empirical analysis of patent oppositions at the EPO

In this Chapter we focus on the issue of patent quality and in particular by taking into account the European patent system. In the first part, we report the results of two surveys that have collected evidence on the current quality of the European patent system from both enterprises and public research organisations (PROs) across European countries. Then we move to the empirical analysis of patent oppositions at the EPO.

The survey data presented in the first part of this Chapter have been collected through a questionnaire disseminated with the help of European industry associations and research organisations. The average quality of the European patent system is perceived to be higher than the one of other systems. The substantive examination services provided by the EPO receive on average a largely positive appreciation. On the contrary respondents indicate that the current administrative structure of the system, with specific regard to the patenting costs and litigation costs, are seriously affecting the perceived quality and effectiveness of the European patent system. Beyond this point, large relevance is assigned to the cost factor, in terms of expectations on a strong reduction of both translation costs and administrative costs related to validation procedures.

The empirical analysis of patent oppositions is the subject of the second part of this Chapter. The trends and characteristics of patent opposition cases in Europe over the time window 2000-2008 are analysed. The observation of the incidence of EPO opposed patents and of the outcomes of the opposition proceedings can provide additional evidence on the quality of the patent examination process. On average, about 5% of all granted patents was opposed between 2000 and 2008. The opposition rate slightly decreases over the years. This trend can be explained in different ways. A first straightforward explanation is that the examination process at the EPO has improved and what we observe is the effect of a "raising the bar" process. Alternatively, the rate of opposition might have decreased because more marginal patents, which are not damaging for competitors and have a lower economic value, have been granted.

We carried out a set of econometric analyses to highlight which patent characteristics have an impact on the likelihood of observing an opposition. Controlling for industry and country effects, it emerges that there is a significant relationship between the likelihood for a patent to be opposed and the number of both backward citations to previously granted patents and the number of citations it received from subsequent patents. This evidence confirms results from previous studies and stresses that patents with higher economic value are more likely to be opposed. A patent showing a European priority is significantly more subject to being opposed than a patent with a non-European priority. In the multivariate analysis we examine the effects of patent characteristics on the outcomes of an opposition, controlling for industry and country effects. We also tried to assess the presence of factors affecting the duration of the opposition proceedings. After controlling for the time of the filing of an opposition we obtain that the number of claims, the presence of multiple opponents, the number of forward citations are positively correlated to the probability of a case being still pending. Patents belonging to Chemistry and Electrical Engineering fields are more likely to be in pending status than those in

Mechanical Engineering. Clearly the duration of the proceedings can be affected by numerous and diverse factors including the characteristics and the amount of new evidence proffered by the parties. In this respect, we stress that although we have identified some factors that seem to show a positive - but rather weak - correlation to the duration of the proceedings, what really matters is the average non negligible duration of such proceedings that generates a prolonged period of uncertainty for both the patent owner and the other companies. Any reform and intervention aimed at reducing the average duration of such uncertainty period would have a positive impact on the quality of the system as a whole. The overall evidence collected through the analysis of opposition cases does not allow us to conclude that there has been a significant decrease in the level of quality along the observed years.

1. INTRODUCTION

In modern world economy, the role of Intellectual Property Rights (IPRs) has become very important due to the increasing value of intangible assets and the clear importance of the innovation systems in firms' competition. Most of the countries are paying more and more attention to the development of their national IP policies and in particular to the definition of better patent procedures which are enacted by the correspondent authorities, the patent offices (POs).

This dissertation aims at improving the knowledge of the patent system in respect of two of the key issues which are currently debated in almost all the advanced economies and which are often strategically valuable elements in many emerging countries: the harmonisation of the patent procedures among world patent authorities and the quality of the offered patent services. Such issues will be respectively analysed in detail for two particular POs, the Japan Patent Office (JPO) and the European Patent Office (EPO) since POs are the pivotal agencies for the development of national patent systems.

The harmonisation of procedures, which deals with the internationality of the received patent applications in a certain PO, will be first investigated through the data from the JPO and then a similar analysis will be extended to other relevant world POs thus based on a different dataset; the quality of the patenting procedure will be examined both from the point of view of the users' perceived quality and wit an econometrical approach by analysing the data on the opposition procedure of the EPO.

This initial chapter aims at introducing the investigated subjects and at presenting the structure of the dissertation.

1.1. HARMONISATION OF PATENT SYSTEMS

Following the path of economic globalisation, where emerging countries are rising fast and knowledge as a source of competitive advantage implies paying greater attention to its protection, the number of international patents has grown significantly over the past two decades (TSR, 2007) (WIPO, 2008). The relevance of patents extended abroad is rising for different stakeholders. The world largest patent offices have already launched several initiatives, such as the Foundation Project in the "Five IP Offices" Project[1] or the several bilateral agreements called "Patent Prosecution Highways", with the aim to create common ground in terms of patent information, procedures and rules: the final goal is to speed the examination process, to reduce the patent backlog and to guarantee the stability of patent rights. A better understanding of the dynamics of the international extensions would improve the patent system. In order to pursue such goal, in this dissertation the foreign patent applications at the JPO are analysed. The JPO has been considered particularly suited for such investigation since it receives annually the largest number of patent filings and, since 1996, has reported a continuous increase in the ratio of foreign to domestic applications.

The peculiarities of the Japanese patent system are described in Chapter 2: it presents the most significant changes enacted in the last two decades by Japan's IP policy which aims at creating an "IP-based Nation"[2]. Such section helps understanding the Japanese IP framework and introduces Chapter 3 which shows the results of the econometrical analysis carried out on the JPO data and focusing on the drivers of foreign patent applications. In order to extend the conclusions, a similar study has been accomplished by involving more world POs at the same time (Chapter 4): the analyses have been realised directly on the data retrieved from EPODOC, one of the EPO databases.

The econometrical analyses on the foreign applications at the JPO provide some significant results. The propensity to patent in Japan appears related to the innovativeness of each origin country. The proximity of the patent system to that of the extending country seems to facilitate the patent extension procedure: the harmonisation of national patent systems in this sense play a facilitating role in the flow of patents from one country to another. Similar conclusions are drawn from the analyses involving more than one recipient PO and reported in Chapter 4.

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[1] For further details about the "Five IP Offices" Project: http://www.fiveipoffices.org

[2] Additional details can be found in the correspondent Appendix 8.1.

1.2. QUALITY OF THE PATENT SYSTEM

The on-going debate on the effectiveness of patent systems focuses on different aspects ranging from quantitative to qualitative perspectives. The reduction of the patent backlog and an improvement of the quality of the granted patents are faced through different initiatives arisen all around the world, such as the IP5 project, the various Patent Prosecution Highways or the still pending debate on the unique "EU Patent" which should be valid throughout the EU 27 member states.

Although the quality issue seems to be a hot topic more for the USPTO, the need to improve the quality of the patent system in order to spur innovation and competitiveness is considered extremely relevant also in Europe, as it has been clearly stated by the European Commission and by the European Council in various recent documents (European Commission 2004 and 2007; Council of the European Union, 2004; European Parliament and Council 2004). Under this perspective, the characteristics and performances of the patent system are strictly connected to the central role of the issuing authority, the PO and to its effort in improving the patenting process in each stage, prior art search, examination, grant, maintenance and any other procedure enacted to improve the quality of the service.

Even if the levels of backlog and quality are not the same in the several granting authorities, the effort to harmonise the different patent systems stresses the relevance of a high quality response to the increased amount of patent filings. In Chapter 5 we focus on the qualitative aspects of the patent system: the analyses and the results are drawn from the PatQual project, "Study on the quality of the patent system in Europe", issued by the European Commission. We first try to shed light on the definition of quality itself as it is perceived by two relevant groups of users: companies and public research organisations (PROs) and then we carry out an empirical analysis of patent oppositions at the EPO, since such a procedure is often considered an effective corrective tool improving the European patent system quality. The econometric estimates on oppositions confirm the positive correlation between patent value and likelihood of opposition and highlight the presence of different approaches in reference to the origin country, stressing the need for a more harmonised procedure when extending patent applications to several POs.

2. OVERVIEW OF THE JAPANESE PATENT SYSTEM

The most relevant offices in the world, since their birth, are the JPO, the USPTO and the EPO, often referred as the "Trilateral Offices". Their relevance is neat in terms of number of patent applications and grants. Among the three POs, the JPO has faced many changes because of the several amendments in the national IP policy especially from the 1990's and even more since 2002 when Japan clearly decided to focus on creating an "IP-based nation".

The next sections will first describe the main historical events in Japanese IP policy, the most significant features of the JPO and how the recent amendments affected the IP system.

2.1. HISTORICAL EVENTS

The historical development of the Japanese IP system traces back to the 19th Century but its real effective implementation is rooted at the beginning of the 20th[3]. Japan's IP system development could be divided in three stages: i) birth of the IP system, ii) reconstruction and catch-up phase after World War II and iii) creation of an IP-based nation.

2.1.1. BIRTH OF THE IP SYSTEM (1718 – 1950)

The first period lasted until 1950's and it represents the dawn of the modernization. The first law regarding what is now called IP was proclaimed during the Edo period, in 1718, but its aim was completely the opposite of promoting innovation. At that time Japan was still at a low technological level and national official policy was of a "closed door" kind in respect to foreign countries: the "Law for New Items" (*Shinkihatto no Ofuregaki* – "Ordinance Prohibiting Innovations") was proclaimed with the purpose of ensuring that absolutely no new types of products would be manufactured. During the Tokugawa military rule, Japan was in fact in an

[3] For a more detailed historical report (and also compared to other countries) please refer to the JPO website: http://www.jpo.go.jp/cgi/linke.cgi?url=/seido_e/rekishi_e/rekisie.htm.

extreme isolationism. After the opening of Japan to the rest of the world, the patent system was introduced following the models of European countries and the U.S. In year 4 of the Meiji[4] Era (1871), Japan publicly proclaimed its own first patent law, called "Provisional Regulations for Monopoly". However, the enforcement of this law was suspended the next year because people found its use very difficult at the time and also because the government office had problems with the operation of this law. Soon it became apparent again that a patent system was indispensable in order to speed up modernization efforts which began after the start of the Meiji Reform. The founding date of Japanese patent law and of the Japan's PO is considered to be April 18th, 1885, when the "Patent Monopoly Act[5]" (*senbai tokkyo jourei*) was enacted. The first application for a patent was "Hotta's Method for Rust Stopping Paint and Painting Method", by Zuishou Hotta on July 1st, of the same year. The patent system was gradually created in the following years.

In 1899, Japan acceded to the Paris Convention for the Protection of Industrial Property and this led to the emergence of many domestic small inventions and to the introduction of foreign technology. In addition, the "New Utility Model Law" was created in 1905 in order to complement the patent system. A shift toward emphasis on applications filed earlier rather than on inventions discovered earlier, which was the policy up until this point, started under the Patent Law which was adopted in year 10 of the Taisho Era (1922).

2.1.2. RECONSTRUCTION AND CATCH-UP PHASE (1950 – 2000)

The second stage of Japanese IP system development comprehends all the policy acts between 1960 (year 34 of the Showa Era), when patent laws were completely revised, and 2000. The primary objective in this period, whose roots are in the post war reconstruction of the nation, was to define a mechanism for promoting diffusion of technical knowledge and generates useful adaptive inventions. This helped in the enhancement of national R&D capacity together with the active absorption of

[4] Meiji Restoration ("renovation" in Japanese) dates back to 1868: its proclamation was the starting point for an extensive international engagement.

[5] It was modelled on American and French law but foreigners were barred from obtaining patent rights.

technologies from foreign countries which finally led Japan to become inventor of original technology. The main amendments to the IP system of this phase were:

- "Foreign Investment Law" and "Foreign Exchange and Foreign Trade Control Law" in 1950[6],
- the request for examination system, launched in 1971[7],
- the accession to the Patent Cooperation Treaty (PCT) in 1978,
- the adoption of the International Patent Classification (IPC) in 1980,
- the introduction of the multiple claim system in 1987 and its revision in 1989: before this amendment only one claim per patent was allowed by law.

The last part of this stage in IP system development was a particular period for Japan, which was facing a deep and long recession and a financial crisis. The 1990's seemed to be a period of crossroads and confusion in Japan (Granstrand, 1999). Having completed the catch-up process in many areas, new challenges were arising as competitiveness became more dependent upon innovativeness. Therefore, many improvements in the IP policy were defined in that direction, such as:

- the signature of the U.S.-Japan agreement in 1994 to get the IP systems closer to each other
- the compliance to Trade Related Intellectual Property Rights (TRIPs) agreement in 1995
- the change from pre- to post-grant opposition in 1996
- the "Ball Spline Bearing" Case[8] in 1998 where Japan Supreme Court decided defining and applying the "doctrine of equivalents"[9], with the effect of limiting the practice of "inventing around"

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[6] They were enforced to regulate technology imports and foreign exchange for the reconstruction and renovation of Japanese industry.

[7] Before this system was introduced, all applications were examined. After 1971, applications were examined only on the request of an applicant. The examination could be performed at anytime within 7 years following the application. This period was reduced to 3 years in 2001.

- the enactment of the so called "Japanese Bayh-Dole Act[10]", in 1999: Universities could retain IP rights in result of publicly funded research

- the Technology Licensing Organizations (TLOs) Promotion Act in 1999 which defined a variety of support to facilitate universities to create their IP centres.

Nagaoka (2005) stressed the relevance of such amendments as driving forces for strengthening IPRs in Japan. All these laws and amendments contributed in making Japan a "research industry" with the world's largest civilian R&D community, which at some point owned half of the world's patents. Japan, with its lack of natural resources, is economically dependent upon R&D and innovativeness. Since R&D is predominantly civilian and concentrated in large corporation, protecting and commercially exploiting this R&D is an issue of national security (Granstrand, 1999).

2.1.3. CREATION OF AN IP-BASED NATION (FROM 2000)

The third and last stage in the development of the national IP system aims to lead Japan toward an "IP-based Nation" (*chizai rikkoku*). Japan's decision to such a deep commitment to IP topic has its reasons in the will to recover from the economic slump in the "lost 1990's", when Japan faced recession due to several factors (bad loans and deflation above all), and in the deteriorating international competitiveness, because of the competition from emerging Asian economies, and from China in particular. China has been catching up to Japan in terms of technological capabilities, while having the advantage of cheap labour. Japan had to be innovative in order to be competitive and to strengthen the creation of technological innovation and the exploitation the produced knowledge. But innovation is the result of human ingenuity and endeavour, so policy makers began to think that they needed to do something to foster innovation. IP was chosen as a tool to encourage it (OECD, 2004).

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[8] "Non-sliding ball spline bearing case": No. Hei 6(o)-1083, Supreme Court, February 24, 1998.

[9] It states that "equivalence" should be determined based on the technologies available when the infringement takes place, not when the patent is granted (Nagaoka, 2005).

[10] The "Bayh Dole Act" or "University and Small Business Patent Procedures Act" is the United States legislation dealing with intellectual property arising from federal government-funded research: it was adopted in 1980.

In February 2002, Prime Minister Junichiro Koizumi launched a brand new policy with an ambitious program aiming at creating an IP-based nation. The first step was the creation of a Strategic Council on IP: it was established in March 2002 and it introduced for the first time the notion of "IP-based nation" and worked on the promotion of the "Basic Law on IP"[11]. With it, Japan clearly identifies IP system as a key point to realize a "sound development of the national economy", the "creation of a rich culture", the "intensification of the international competitiveness" and a "sustainable development of Japanese industry" (Basic Law, 2002). The central point of the Basic Law is the promotion of a program for the development of an IP virtuous cycle: from "creation" (filing of patents, trademarks, utility models…), to "protection" (issue of IPRs), to "exploitation" (profiting from IPRs) and to "creation" again (trough re-investment of profits).

Japanese government decided to establish the so called "IP Strategy Headquarters[12]" with the intent to protect and regulate every category of IP (patent, design, trademark, trade secret, copyright, etc.). The Basic Law provided also specific dispositions about industry-academia-government relationships and coordination in order to promote "creation" phase of the IP virtuous cycle. Inventors in business organizations received formal guarantees about rights holder and invention process. State and local government are more actively involved and responsible in continuously promoting and improving the system. Universities were endowed with more responsibilities and assured on their independence; their functions were expanded by adding to the conventional ones (such as education and research) the technology transfer function. Universities were requested to enhance their IP-focused Organizations (TLOs), following official rules and regulation on IPRs ownership, and to secure innovation financing by supporting inventors in the patent prosecution fees. In order to achieve this plan, circa 50 University Intellectual Property Headquarters were established across the country. In parallel, the system of TLOs was widened and improved.

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[11] Law 122, November 2002, in force from March 2003 and reviewed in 2006.

[12] Established in March 2003, its Chairman is the Prime Minister (at the beginning it was Koizumi) and it has an across-the-board nature: the board is composed by 10 experts including 4 university professors, 3 CEO's of private firms, an attorney, a patent agent and a scientist.

The Basic Law was indeed the first step in the formulation of a wider and long term IP Strategic Program, covering the subsequent years[13] and still running. All those actions served to foster each part of the IP virtuous cycle and in particular "protection". In this view, a relevant modification was the IP enforcement renovation, started in 2003 with the Civil Proceeding Revision, which led in April 2005 to the formation of an "IP High Court" with exclusive jurisdiction. IP High Court goal is to decrease, or even eliminate, the waiting time of decisions, and speed up the patent life cycle so that IP owners can benefit from their inventions more quickly (Wada, 2005).

Considering the phase of "exploitation" in the IP virtuous cycle, Japan focused on promoting patent licensing in several ways. On the domestic side, it has been increasing the number of patent licensing advisers, organizing fairs and seminars and developing IP-skilled human resources (in terms of both quantity and quality, in business and academic sectors). On the international side, Japan has been fostering cooperation to achieve a mutual patent recognition system in other IP offices and the realization of a globally consistent patent system.

Japanese economy recently shows a sign of recovery, which tends to support positive effects from the adoption of national IP policy (Takenaka, 2005). Although the annual number of patent applications filed in Japan has remained high, with more than 400,000 filings since 1998, it has recently started to slowly decline. One factor behind the decrease is that many Japanese companies has been changing their strategy for IP: from aiming at acquisition of a large volume of patents, mainly for the purpose of the protection of improved manufacturing technology and support of product development to follow competitors, Japanese firms now aim at the acquisition of beneficial and high-quality patents when carrying on their core business. The new requirement has made national patent applications become more complex and advanced in content. The average number of claims in patent applications in the JPO increases steadily leading to a growth in the JPO workload.

[13] For example in the period between 2003 and 2006, more than 1000 IP-related policy instructions were promulgated regarding measures against counterfeits and pirated copies, a new customs tariff law, the expansion of the system for stopping the import of infringing goods, media contents business, the revision of examination guidelines on medical method patents etc.

Another factor behind the decrease in the number of patent applications is that more and more Japanese applicants have become aware of valuing application abroad with a global-filing strategy while carefully selecting domestic applications. Meanwhile, due to progress in the globalization of business activities, the number of international applications filed in at the JPO under the PCT in 2007 was 26.9351, continuing to indicate the tendency to rise though the growth is becoming slower. At the same time, the JPO serves the role of International Searching Authority, examining PCT applications with an increase in its workload.

Since the demand for patents with high quality and international protection has increased, the JPO started to focus on the promotion of quality management and of international cooperation in examination activities. The most important international issues are the development of relationships with the USPTO and the EPO (in the "Trilateral Program"), the SIPO and the KIPO. Other relevant initiatives are:

› the Patent Prosecution Highway (PPH): a framework for allowing, on request by the applicant, accelerated examination in the Office of Second Filing with simplified procedures, with respect to the application whose claims are determined to be patentable in the Office of First Filing[14];

› JP-Fast Information Release Strategy (JP-FIRST): a program launched in April, 2008, aiming at qualifying basic patent applications claiming priority under the Paris Convention for an early start of examination and to release the JPO's examination results to the rest of the world as soon as possible;

› New Route: a framework in which an application under the Paris Convention is deemed to be filed in the Office of First Filing and the Office of Second Filing on the same date and by transmitting the results of the first action in the Office of First Filing to the Office of Second Filing within a certain period; in order to achieve the New Route, a change in the legal systems of both Offices becomes necessary, so that the JPO and the USPTO are conducting an analogous pilot

[14] As of April 2008, the PPH have been conducted between JPO and each of the following offices: USPTO, KIPO, UKIPO (U.K. patent office) and GPTO (German patent office). The number of Offices with which the JPO conducts the PPH is expected to be expanded in the future.

program since January 2008 using frameworks possible under the current legal systems.

In order to manage the process of transformation, among the most recent achievements it is worth to be mentioned that the Policy Committee on Innovation and Intellectual Property (PCIIP) was set up on December 18, 2007, with the aim of discussing desirable IP policies for Japan from a global perspective to further promote innovations in the drastically changing environment surrounding the IP system. PCIIP's activities led to the promulgation of some laws in April, 2008: the "Bill to Partially Amend the Patent Act[15]" and "Other IP-Related Acts". They were formulated with the perspective of establishing an IP system more friendly to users and able to grant IPRs strategic utilization and adequate protection.

On such a spur, the "IP Strategic Program 2008" was officially adopted on June 18. It highlighted three strategies: "further strengthening [of] the global competitiveness of Japanese Industry in priority fields", "[of] the activities in the international market" and "leadership in dealing with global issues and Asian issues" (TSR, 2008).

2.2. CHARACTERISTICS OF THE JAPANESE PATENT SYSTEM

The post-war Japanese patent system was originally established in the 19th Century not only to encourage domestic inventors, but to facilitate technology transfer from the West: it has been described as a mechanism for promoting both "diffusion and exclusion" (Ordover, 1991; Granstrand, 1999; Cohen et al., 2002). It contributed positively to productivity growth, to the extent that it enhanced diffusion of technical knowledge through the Japanese economy and generated useful adaptive inventions. At the same time it safeguarded exclusive use of technologies: once protected, use of technology becomes more insulated, serving to inhibit technology diffusion, in the long run it could inhibit incentives for fundamental research and so diminish growth. IP system in this sense reflected the trade-off between positive

15 The Bill includes both new laws and revisions of previous rules, such as a revision of the non-exclusive license registration system, a revision of the time limit for filing a request for an appeal, specifications on expanding the network of electronic exchange of priority documents, a reduction of patent/trademark fees, etc.

growth effects from incentives for invention and negative growth effects from limited access to information (Maskus and McDaniel, 1999).

Despite the high ratio of domestic-to-foreign applications for patents and utility models, Japan has been a significant net absorber of foreign technologies. The ratio of payments to receipts of royalties and license fees in Japan's "technology balance of payments" exceeded 4.0 in 1973. However, this ratio declined to near-balance by 1994, indicating Japan's rising relative position as a technology supplier. These findings are consistent with the fact that over the period concerned Japan was in a technological "catch-up" phase. Diffusion and imitation were more important than pure invention (Maskus and McDaniel, 1999).

The Japanese patent system emphasized the disclosure function of patents in order to follow what the Japanese refer to as "the conventional catch-up style patent policy". Ordover in 1991 argued that the Japanese patent system was a "complex web of policy choices more or less consciously structured to affect R&D diffusion while maintaining overall incentives for R&D investment" in a way to subordinate "the short term interests of the innovator in the creation of exclusionary rights to the broader policy goals of diffusion of technology".

The Japan's IP system led to the realization of a specific framework. Although R&D spending as a percentage of GDP was higher in Japan than the U.S., intra-industry R&D knowledge flows and spillovers were greater in Japan than in the U.S. and the appropriability of rents due to innovation less (Cohen et al., 2002). Uses of patents differed between the two nations, with strategic uses of patents, particularly for negotiations, being more common in Japan. A key reason for less appropriability and greater intra-industry R&D spillover in Japan appeared to be that patents diffuse information across rivals more readily than in the U.S.. Such cross-national difference was not only due to diverse policies but also to the approaches in patenting activities in the two nations (Ordover, 1991; Cohen et al., 2002).

Consistent with the assumption of greater intra-industry spillovers in Japan and of IP protection being weak, Cohen et al. (2002) found that the "imitation lags" were much more compressed in Japan than in the U.S.. At the same time, in Japan, it was conceivable that almost all products could be considered "complex[16]" because, in Japan, patents encompass fewer claims, and the claims themselves tend to be interpreted more narrowly, generating more patents per product and, in turn, widespread technological interdependence. But, in complex product industries, firms rarely have proprietary control over all the essential complementary components of the technologies they are developing, creating a condition of mutual dependence that fosters extensive cross-licensing, related negotiations and information sharing. As compared to discrete product industries, patents are used less often to enforce exclusivity and more to secure market access (by conferring access to key technology owned by others) and freedom of operation (by conferring an ability to countersue if sued, thereby discouraging suits).

For example, in Japan in the mid 1990's, the average number of claims per patent was less than five, whereas in the U.S., it was approximately 15. This was particularly the case in pharmaceuticals (and chemicals more generally), where Japanese firms had lobbied for stricter interpretations of claims in order to create space for domestic patenting around European and American pharmaceutical company patents.

The "strategic" uses of patents (e.g. to block others' patents, use in negotiations, to prevent infringement suits) was common in both nations but more prevalent in Japan (Cohen et al., 2002). For this reason, it was more difficult to protect rents due to invention in Japan than in the U.S.. Consistent with this observation, R&D-related information flows across rivals and R&D spillovers as well, are significantly greater in Japan. Patents are the most important channel for such information flow in Japan.

The use of patents in Japan for maintaining market access and freedom of operation rather than for exclusion was reinforced by the comparatively low payoffs to infringement suits in Japan. Patents become weapons in mutually reinforcing, non-cooperative strategic interactions where firms feel increasingly compelled to patent because either they need to protect themselves from suits or from being blocked, or they want to block rivals or use patents as bargaining chips in negotiations. If patenting is excessive, however, the associated social costs may be offset in Japan in

[16] For a the use of the definition see Cohen et al. (2002).

the sense that patents, *ceteris paribus*, diffuse information more effectively and the incentives to litigate are less (Cohen et al., 2002).

All patent systems require an invention to satisfy some basic characteristics such as novelty, utility, and inventive step ("non-obviousness") in order to be patentable. The stringency of these standards sets the bar for earning exclusive rights. Patent breadth defines the extent of the claim protected and permissible activities in using the patented information. Thus, having low novelty standards and recognizing only narrow claims encourages small and incremental inventions while limiting incentives for R&D into fundamental technologies. This is especially the case if the patent laws provide liberal treatment of reverse engineering of patented products, thereby promoting imitative forms of R&D. In this context, an important feature of the Japanese patent system was its reliance on utility models and industrial designs. The required level of inventiveness of a utility model, as well as the scope and duration of protection, has been less than those for a standard patent in Japan. Further, industrial designs only needed to demonstrate novelty and not inventiveness in Japan in order to earn patent protection (Maskus and McDaniel, 1999).

In the following paragraphs, we will provide some insights on the most relevant issues which characterise the current Japan's IP policy[17].

2.2.1. FIRST-TO-FILE RULE

In granting patents, Japan follows a first-to-file rule. This rule eliminated many lawsuits regarding the identity of the original inventor and induced rapid disclosure as firms were forced to file sooner than they might otherwise elect under the alternative priority rule, that is first-to-invent rule (Ordover, 1991; Maskus and McDaniel, 1999). However, numerous opportunities for conflict exist under the first-to-file procedure and, as a result, firms often resort to licensing. In Japan firms are under pressure to file as early as possible and are free to amend the application during the first months after filing, before publication, heightening the possibility of similarity among patent claims and inducing firms to issue licenses to settle differences in these claims. In

[17] The current patenting process is described in detail in the correspondent Annex 8.1 where the procedural flow chart is shown and the relevant features of the Japanese patent system are more extensively discussed in reference to the most recent amendments.

addition, if two or more applications relating to the same invention were filed on the same date, applicants were required to reach an agreement among themselves as to who would obtain the patent or else none would receive it. This aspect of Japan's patent policy illustrates how it encourages voluntary agreements and discourages confrontation. It is claimed that the first-to-file rule has served well those Japanese firms that can patent around original inventions and have large patent staffs to get through the system more quickly. Accordingly, it has poorly served original inventors and small firms (Maskus and McDaniel, 1999).

2.2.2. NUMBER OF CLAIMS

In 1987, Japan's industrial property law was amended to eliminate the “single claim requirement” on patent and utility model applications. The former law encouraged several narrow applications, often centred on one novel invention. This revision contributed to the decline in utility model applications reducing their relative attractiveness (Maskus and McDaniel, 1999). The number of claims in one application increased rapidly after changes in the patent system and, at the same time, there was a reduction in the growth of patenting. With the introduction of the “Revised System of Multiple Claims” in 1989, inventions that previously had to be filed as separate patent applications could be filed as a single application with multiple claims (Goto and Motohashi, 2007).

The single claim system allowed firms in Japan to “invent around” original patent applications more easily by virtue of limiting the extent of what might be infringed by followers. Japanese firms received protection on technologies that were only slightly modified from the original invention. In addition, the single claim requirement provided an incentive for “cluster filing” patent applications. This procedure involved filing a myriad of accompanying applications along with every principal application, prohibited competitors from obtaining similar patents, and forced cross-licensing. The single claim requirement coupled with cluster filing enabled firms in Japan to “box in” the original inventions embodied in existing applications, effectively forcing the original applicant to cross-license its technology to those firms filing opposition claims. The latter firms were often the same firms that filed applications on technologies invented around the original claim (Ordover, 1991; Maskus and McDaniel, 1999).

Although single claims are no longer a legal requirement, Japanese patent officers and firms still seem to favour narrowly defined applications. On average, in 2007, an application filed at the JPO contained 9.8 claims (9.5 in 2006), one filed at the EPO contained 18.0 claims (18.2 in 2006), while one application at the USPTO had 20.1 claims (20.5 in 2006). There still seems to be a tradition to have fewer claims in a single patent. Thus, a single technology continues to correspond to more patents in Japan (Maskus and McDaniel, 1999).

2.2.1. CHANGE TO POST-GRANT OPPOSITION, INVALIDATION AND TRIAL

Until 1996 Japanese patents were subject to "pre-grant opposition": for three months after a patent examiner gave notice that he intended to grant a patent, competitors or anyone else could challenge the validity of the prospective patent, and the examiners often relied heavily on the evidence provided during this period of pre-grant opposition in making their final determination. Under Japanese patent law, third parties could oppose a patent application during the disclosure period on the basis of novelty requirements, non-obviousness, and industrial applicability. The applicant had only a few months to provide an adequate response or the application was rejected. The pre-grant opposition procedure has been termed a `loophole' in the Japanese patent system; it was often specifically directed toward foreign patents covering critical technologies. These opposition proceedings could be costly for the original applicant and could lengthen the pendency period, thereby decreasing the value of patents awarded. Large Japanese firms maintained sizeable patent staffs that specialize in pre-grant oppositions and thus gained an advantage in subsequent licensing agreements.

In 1996, pre-grant opposition was replaced in Japan with a system of post-grant opposition. Third parties had six months from the JPO's announcement of their intent to grant to challenge the validity of the patent. No analogous opposition process applies to the U.S.. Rather, the validity of a U.S. patent is more typically challenged in the courts after a patent is issued. Thus, the Japanese patent system places more information in the public domain sooner, induces the filing of a patent application sooner in the innovation process, and the opportunity for pre-grant opposition strengthened incentives to monitor competitors' patent filings early on (Cohen et al., 2002).

The change to post-grant opposition accelerated the process of granting patents, and all pending patent applications under pre-grant opposition period prior to 1996 were processed during that year. This resulted in a spike in the number of patents granted in 1996 (Goto and Motohashi, 2007). However, in most of the IP offices, the numbers of opposition or invalidation requests is loosely correlated with the number of patents granted[18]. In general, there is an upward trend in the numbers of opposition or invalidation requests which may reflect an increasing interest in challenging granted patents by third parties. In Japan, IP-related lawsuits have always been less than in the other countries and, even when infringement is proven, pay-outs tend to be small if compared to U.S. or Europe. In addition to the difficulty in proving the causal link between infringement and lost profit, the opportunity cost was not used in estimating the lost profit. The patentee would incur only the incremental cost to achieve the output that he would be able to produce if there were no competing entry infringing his patent, in this way underestimating the damage[19]. The court rulings, however, began to adopt the concept of opportunity cost since the middle of 1990's. A similar problem existed in the determination of royalty as damage. When the causality between infringement and last profit is not proven, the damage is estimated based on the royalty. Thus, it was not based upon the hypothetical ex ante royalty negotiation between the two parties as in the United States, which could reflect the profit made by the infringing firm (Nagaoka, 2005).

Moreover, in recent years Japan faced a sudden drop in the number of patents opposed concurrently to an increase in the number of trials for invalidation. The reason is a law revision enacted in 2003 at the JPO. The system of opposition after an examiner's decision to grant a patent was integrated into the system of trial for

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[18] The exception is Germany where requests have declined at the same time that the number of granted patents has increased.

[19] Until 1998, for example, the highest payout in a Japanese infringement suit was approximately 3.2 million U.S. dollar as compared to over 900 million U.S. dollar in the 1990 Polaroid versus Kodak decision in the U.S.(Cohen et al., 2002).

invalidation of a patent. This prompted the number of demands for trials for invalidation of patents to increase in 2004, showing a decline thereafter.

3. FOREIGN APPLICATIONS AT THE JAPAN PATENT OFFICE – AN EMPIRICAL ANALYSIS OF SELECTED GROWTH FACTORS

3.1. INTRODUCTION

Following the path of economic globalisation, where emerging countries are rising fast and knowledge as a source of competitive advantage implies paying greater attention to its protection, the number of international patents has grown significantly over the past two decades (TSR, 2007) (WIPO, 2008).

The relevance of patents extended abroad (where the patent owner obtains patent protection in foreign countries) is rising for different stakeholders. The world largest patent offices have already launched several initiatives, such as the Foundation Project in the "Five IP Offices" Project[20] or the several bilateral agreements called "Patent Prosecution Highways", with the aim to create common ground in terms of patent information, procedures and rules: the final goal is to speed the examination process, to reduce the patent backlog and to guarantee the stability of patent rights. At the same time, globalisation pushes firms to gain protection for their innovations in different countries: production sites may be in a different location from the destination market and even competitors may be in another region of the world.

A better understanding of the dynamics of the international extensions (foreign applications) would improve the patent system.

In this Chapter the foreign patent applications at the Japan Patent Office (JPO) are analysed. The JPO receives annually the largest number of patent filings and, since 1996, has reported a continuous increase in the ratio of foreign to domestic applications. The analyses on the data collected from the JPO Annual Reports are performed by taking into account the drivers that the previous literature has recognized even if not always unanimously. The regression results suggest that the growth in international filings at the JPO is positively related to the innovative

[20] For further details about the "Five IP Offices" Project: http://www.fiveipoffices.org

capabilities of the extending (originating) countries and to the international harmonisation of the patent systems.

3.2. RELEVANCE OF INTERNATIONAL PATENTS

An international patent is a patent which has been filed reporting an assignee whose nationality is not the same of the examining and granting office. A more practical definition makes use of information on priority documents: if a patent or a patent application has a priority in another patent office, from a different country, it can be considered an international patent which has been extended from the first recipient country. Since in most of the cases[21], the applicants, that is the patent rights owners, decide to file applications in the country in which they reside and later to extend the patent to all the countries where they have an interest to gain protection, the two definitions can be considered overlapping.

If we consider the assignee, the most common situation is the case of a firm that has already obtained, or is on the way to obtain, a patent in its home country and aims to obtain another patent for the same invention in a foreign country. Such a firm may be looking for official protection of its exports from imitation, but it may also be pursuing more complex strategies according to the presence of affiliates, franchisers, allied firms, or competitors in the destination country.

In a few cases, international patents may be defined as such on the basis of the nationality of the inventor, rather than the assignee. In this case, any patent applied for in country A in order to protect an invention by an individual (inventor) from country B can be defined as international[22].

International patents have been used in economics and innovation literature as proxy for different measures, due to their peculiarities. Many studies agree that international patents can be considered as representatives of a country's best

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[21] van Zeebroeck et al. (2009), analyzing a dataset of one and a half million EPO applications filed between 1982 and 2004, found that a little more than 3% of the applications are filed in by non-US applicants thus reporting a US priority, and about 1.5% of applications are submitted by a US applicant with a non-US priority.

[22] When international patents are analyzed from the point of view of inventor's nationality, the focus is usually more on the topic of collaboration in international employees, allowing conclusions to be drawn on the involved labour force, the kind of joint ventures and workforce mobility.

inventions, stressing their value in terms of inventiveness and radicality and of technology transfer. According to this assumption, Pavitt (1983) stated that the probability for a patented invention to be developed into a full-fledged innovation is higher for patents which are extended abroad, and especially to U.S., (the most technologically advanced country in the world, and still the biggest market). The same idea is shared by Evenson (1984), Dosi (1990), Eaton and Kortum (1996 and 1999), Kortum (1997), Furman et al. (2002). The concept was refined by Watanabe et al. (2001), who agreed that patent applications to foreign countries, not granted patents only, provide a better demonstration of innovation for each of the respective countries.

As noted in Johnston and Carmichael (1981), since patents are one of the few output measures of innovative effort, they play an important part in guiding science and industry policy, since they are counted to indicate technological performance (Pavitt, 1983) and are expected to bear some relation to R&D expenditure (Griliches, 1990).

It is generally accepted that many companies (especially the large ones) find it relatively cheap and easy to file all sorts of patents, including those for inventions of unknown or untested value, in their home country[23]. On the contrary, filing patents abroad is so expensive (due to extra fees, translations costs, etc.) that application efforts are limited to highly valuable inventions.

International patents can be considered a more precise measure of the inventive output or of the innovative effort than the total number of patents. Since we have no direct measure of inventive output, patents are indirect evidence of research output, and where patent protection is sought reflects where inventors expect their ideas to be used (Eaton and Kortum, 1996). In the same study, the authors considered international patents as one of the indexes to measure productivity growth. They modelled productivity growth from inventive activity in different countries. Furman et al. (2002) addressed the issue of the economic growth focussing on the analysis of "national innovation capacity", that is the ability of a country to produce and commercialize a flow of new-to-the-world technologies over the long term:

[23] See also Criscuolo (Criscuolo, 2006) for a deeper analysis of the "home advantage" effect.

international patents were used as a direct component in measuring national innovation capacity. Furman et al. (2002), as in other studies such as Bosworth (1984), Maskus (1997), Branstetter et al. (2006), highlighted the disclosure function of patents[24] which allows measurement of technology and knowledge transfer. International patents are more precise since they catch the real innovation due to high costs in going abroad: it is the true measure of innovation and of innovation worth to be "traded".

The decision to ask for a patent grant in a foreign country is usually connected to the need to receive official protection from imitation but it could be also rooted to strategic intentions according to the presence of affiliates or competitors in the destination country.

The traditional motive is to receive protection from imitation (Ordover, 1991). Protection can be sought because patent assignee targets the destination country as an existing or only potential market and to prevent imitators from copying and selling back (Criscuolo, 2006; O'Keeffe, 2005; Yang and Kuo, 2008). The traditional motive applies also in the case when the destination country is seen as a place to establish new production plants[25] (Eaton and Kortum, 1996; O'Keeffe, 2005; Yang and Kuo, 2008).

Other reasons to apply for a patent in a foreign country are linked to competition in order to receive a grant where competitors produce or sell (Ordover, 1991). The aim in this case is to prevent competitors from patenting, that is to realize a blocking strategy in order to reduce competitor's space while defending own space (Eaton and

[24] In relation to their disclosure function, patents can be considered as an input measure to innovation.

[25] Eaton and Kortum (1996) state that it specially holds where a limited investment is needed to manufacture the product, making it easy to shift manufacture in the destination country. A foreign patent allows to reduce damages from the risk of off-shoring: even if the country of manufacture may not be seen as a significant target market for the product, the mere fact that the production is located there may lead to copy-cat production facilities resulting from know-how and/or technology leakage (O'Keeffe, 2005). In addition, destination country might actually be not covered by any real interest but it could have been chosen in the batch of possible markets in the International or regional procedure, due to an initial uncertainty in defining the final market country.

Kortum, 1996; Blind et al, 2006). Patent portfolios serve to scare off new market entrants by creating patent fences[26].

With the opposite function to collaborate instead of compete, patents change to become instruments to bargain, since they guarantee royalties from licensing and allow acquisition of public or private funding and cooperation with other institutions and have positive reputational effects. In the work of Blind et al. (2006), the two most relevant motives are the improvement of the position in negotiations with other enterprises and preventing infringement lawsuits by third parties. Licensing income, accessing foreign markets and the internal evaluation of R&D productivity play significantly smaller roles.

Ordover (1991) focused on the reasons and on the brakes to request patent protection. Among the motives which limit patent propensity, he noted that the preference can be on patenting but also on other strategies for technology exploitation, such as secrecy, market lead time[27] or even utility models (petty patents); moreover there might be a lack of competition, of patent culture or of management attention; patent assignees could have faced negative past experiences (for example trials ended with low damages) or evaluate the enforcement level inadequate (weak protection, absence of litigation).

3.3. THE JPO IN THE INTERNATIONAL CONTEXT

Japan has a population exceeding 120 million inhabitants since the middle of 80's, a Gross Domestic Product (GDP) per capita among the world highest and, according to United Nations Human Development Index, it is one of the 10 most developed countries. All these characteristics should make the Japanese market very attractive in terms of size and consumption capacity and consequently attract patents from foreign firms which wish to protect the inventions that add value to their products. Besides, the country has scarce natural resources making it a traditional

[26] Different patenting strategies are often defined as pooling, stacking, blocking, flooding, clustering, bracketing, blietzkrieging, harvesting.

[27] Alternative forms of IP protection are often preferred to patents; see for example the works of Cohen et al. (2000 and 2002).

investor on intangibles. In spite of this, the ratio of foreign on total patent applications has always been very low until the 90's.

Japan has always been considered a country where application for a patent is hard for foreigners. Until the second part of the 90's the ratio of domestic on total patent application was constantly over 90%. Different reasons were claimed ranging from the strength and the ability in building entry barriers of Japanese groups of firms (the "Keiretsu"), to the unique and close IP system which allowed only applications in Japanese language and granted a low level of enforcement and damages, to the suspicion that Japanese tend to buy Japanese products and international brands cannot penetrate market (Ordover, 1991; Yang and Kuo, 2008).

In recent years, the Japanese IP system has been the subject of a series of law amendments which have deeply changed it. The most significant reforms have been the introduction of the possibility to file applications with more than one claim[28] in 1987, the accession to Trade-Related Aspects of Intellectual Property Rights (TRIPS)[29] agreement in 1995 and the launch of a Government-promoted policy aiming at making Japan an "IP-based nation": its starting point was the "Basic Law on IP" in 2002 (Basic Law on IP, 2002).

The analysis of foreign patent applications counts shows a clear increase from 1996, following the process of harmonisation started with TRIPS accession and a second boost in 2004, two years after the launch of the "IP-based nation" program (Figure 1).

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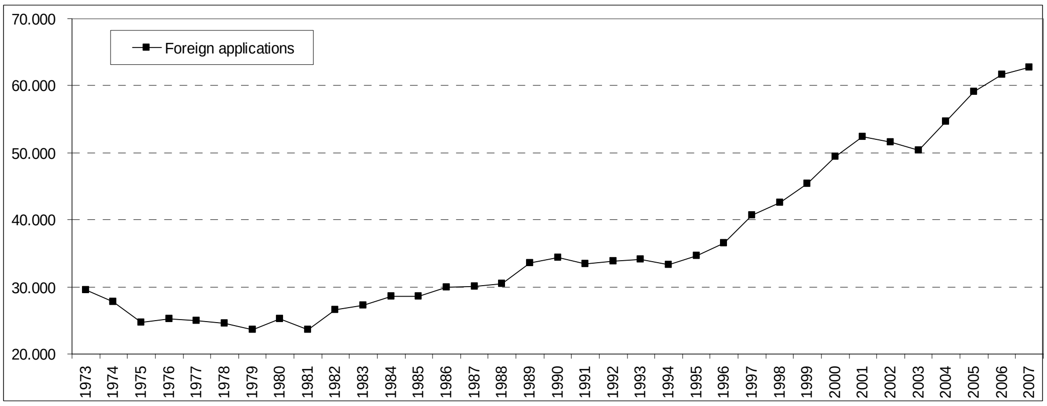
[28] In 1987, with the introduction of the "Revised System of Multiple Claims", a unique feature of the Japanese IP system was abolished: the "single claim requirement" on patent and utility model applications was eliminated. The former law encouraged several narrow applications, often centred on one novel invention. The number of claims in one application increased rapidly and, at the same time, there was a reduction in the growth of patenting: inventions that previously had to be filed as separate patent applications could now be filed as a single application with multiple claims (Goto et al, 2007). Although single claims are no longer a legal requirement, Japanese patent officers and firms still favour narrowly defined applications. On average, in 2007, an application filed at the JPO contained 9.8 claims (9.5 in 2006), one filed at the EPO contained 18.0 claims (18.2 in 2006), while one application at the USPTO had 20.1 claims (20.5 in 2006) (TSR, 2007). There still seems to be a tradition to have fewer claims in a single patent.

[29] Accession to World Trade Organization and related adhesion to TRIPS agreement pushed Japan to harmonize its IP system to the rest of the WTO members. The most relevant amendment was the possibility to file patent applications in English, sensibly reducing patent costs pending on foreign applicants.

Figure 1 Yearly foreign patent applications at the JPO (Source: JPO Annual Report, several editions)



In the same period, the EPO and the USPTO reported an increase in foreign patent application too (Figure 2). However, the increase in these two offices seems to be proportional to the general increase they faced in patent applications, both domestic and foreign. The ratio of foreign on total applications does not change much at the EPO and the USPTO while it keeps growing at the JPO, even if it is still much lower than its European and U.S. counterparts.

Figure 3 highlights the variation of the ratio of foreign to total filings in the three offices: the value in 1996 is the base (100%) and the following years are compared to it. Compared to the other two major patent offices, USPTO and EPO, data on the Japanese Office show some peculiarities. In terms of absolute numbers of international filings, yearly the JPO receives an amount comparable to the quantity filed at the EPO and to one third of what is filed at the USPTO. The ratio of foreign to total applications has remained around 45-50% for the EPO and the USPTO, quite consistently since 1995. On the contrary, the ratio for the JPO increased in the period.

Figure 2 Figure 2 Yearly foreign patent applications at the JPO, the EPO and the USPTO (Source: TSR, from 2003 to 2008 edition)

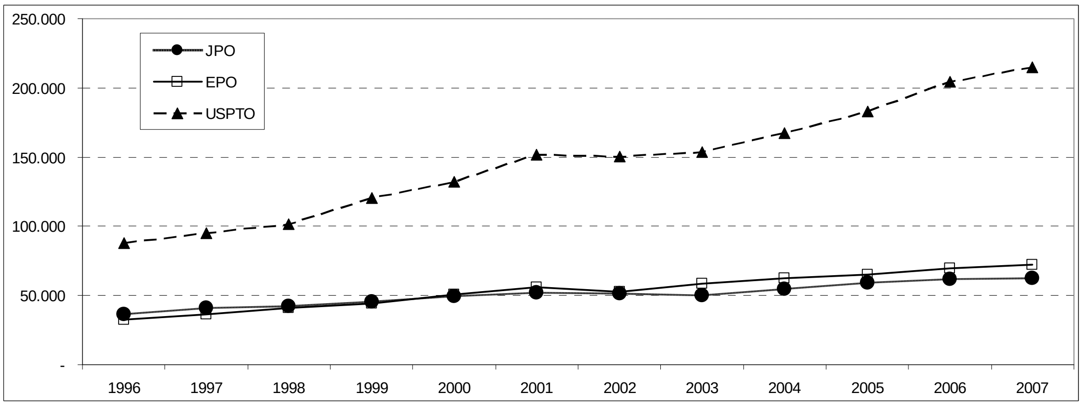
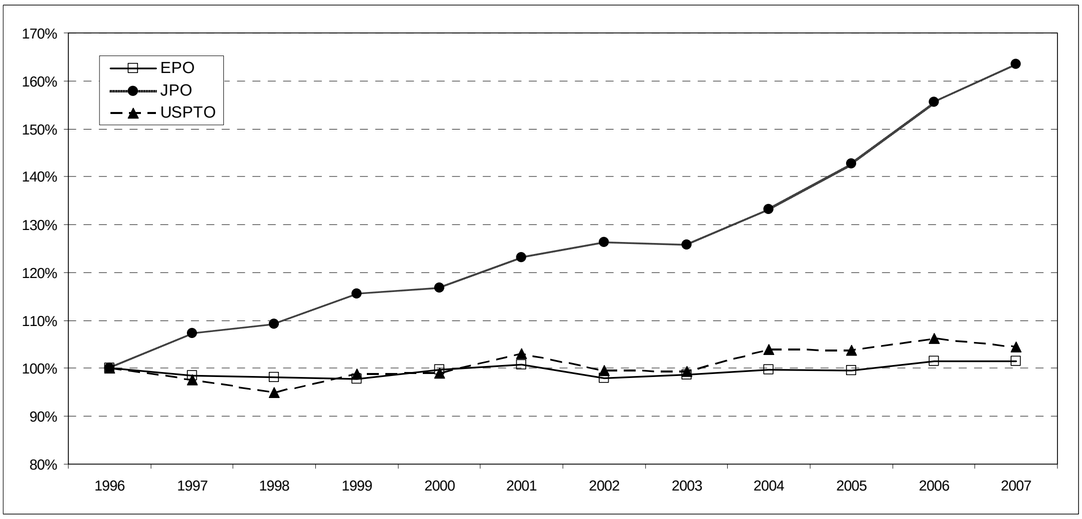


Figure 3 Figure 3 Ratio of foreign on total patent applications at the JPO, the EPO and the USPTO: variations from 1996 values (source: TSR, from 2003 to 2008 edition)

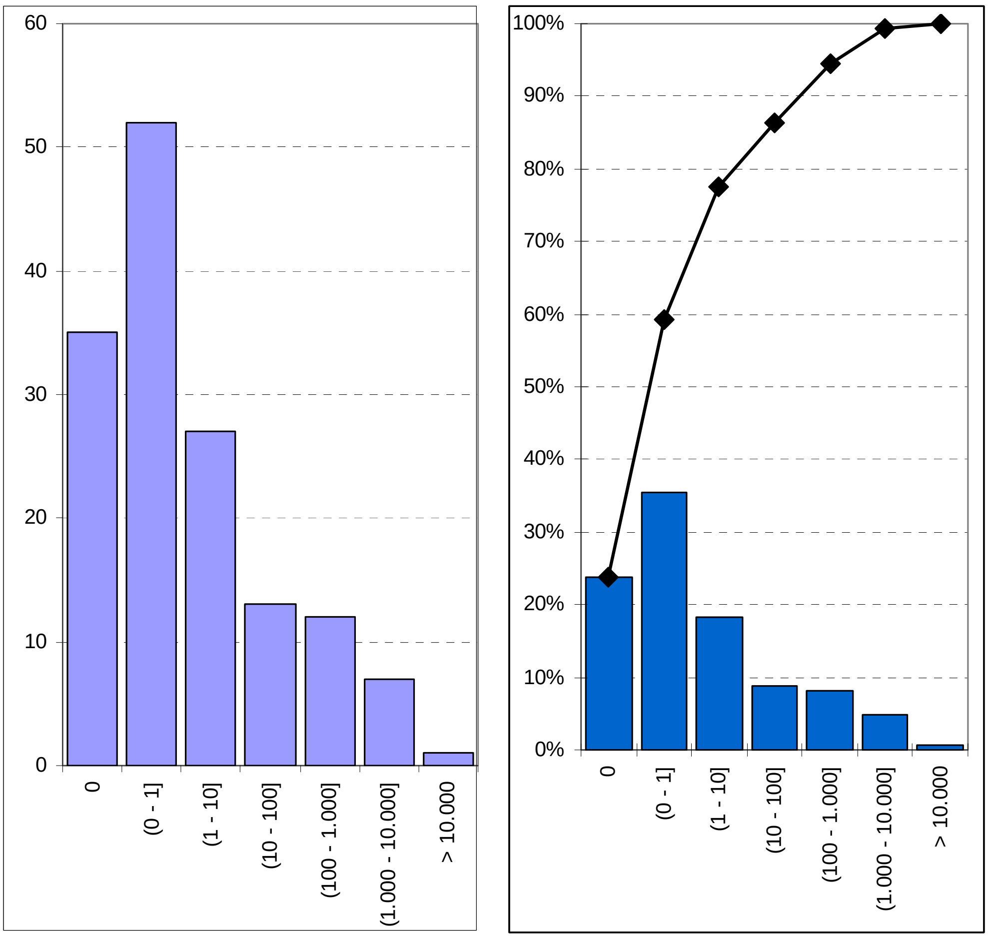


Data collected from several editions of the JPO Annual Report[30] allowed the creation of a dataset which includes all the countries from which applicants have applied for at least one patent, one utility model, one design or one trademark, in order to consider all the nations which have requested at least one kind of IPR at the JPO between 1991 and 2007. The resulting dataset contains 147 countries. Among them, applicants from 112 countries have submitted a request for at least one patent in the whole period; among these, applicants from 87 nations applied for either no or

[30] JPO Annual Reports are available on the official website. By way of example 2008 edition can be downloaded here: http://www.jpo.go.jp/shiryou_e/toushin_e/kenkyukai_e/annual_report2008.htm (last access on July 2009).

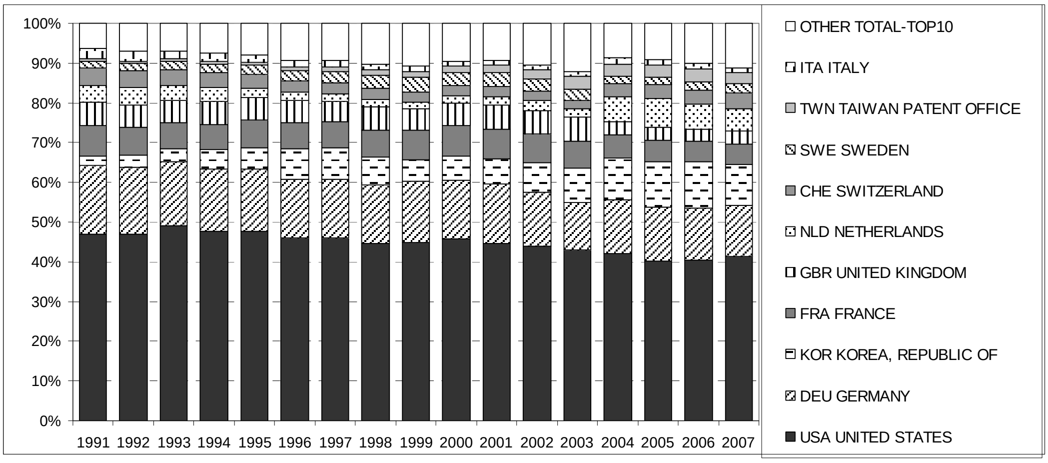
one patent per year on average while only the U.S. applicants applied for more than 10,000 patents per year on average. As it can be seen in Figure 4, nearly 60% of the selected countries didn't request any or made only one application in the whole period.

Figure 4 Count of countries per intervals of average yearly number of applications at the JPO in the period 1991 – 2007 and percentage of total countries applied for an IPR in the same period; line is the cumulative (source: several JPO Annual Reports)



The composition of non-resident applicants at the JPO is presented in Figure 5. It shows the percentages of the top 10 countries in filing patent applications at the JPO. Their shares total circa 90% of the total applications filed in but it is decreasing. If the top 20 countries are considered, the total represented share each year more than 97%. U.S. alone represents more than 40% of the total yearly applications but the percentage is decreasing along the years, leaving room in particular to the Republic of Korea and to the miscellaneous group which includes countries like Canada, Australia, Denmark, Belgium, Austria, China, Spain, Russia, Brazil and India.

Figure 5 Share of the top 10 applicant countries to the JPO of total non-resident applications



3.4. DRIVERS TO INTERNATIONAL PATENTS

Scientific literature addressed the question of what has an impact on foreign patent application in several studies. Different approaches focused on different aspects but the variables affecting the propensity to patent abroad can be grouped in three main groups: the first describes the extending countries with their peculiar features, the second focuses on the recipient country and the third group evaluates the relations between the two involved countries, extending and receiving patents.

3.4.1. EXTENDING COUNTRY CHARACTERISTICS

The first group of drivers aims at evaluating the innovativeness of the applicant countries. It accounts for the extending country's characteristics, since nations are in different development stages with unique features. Each country has its own capacity to generate innovations and so patents. It is related to its wealth and ability in creating research output which is formalized in patent applications. Besides, each country has access to different amounts of human and economic resources and follows different strategies and policies in order to set its level of commitment to

R&D. This determines different levels of research input with direct influence on the patent output.

Some studies tried to measure the inventiveness of a country, as defined by Eaton and Kortum (1996) or the "National Innovation System", as in Grupp and Schmoch (1999), through education, industrial relations, technical and scientific institutions, government policies, cultural institutions and other variables. Furman et al. (2002) defined the particular system which generates patents using the term "Common Innovation Infrastructure", including both the resources which act as input and the real national infrastructure which acts as the means to create output.

The wealth of a nation, proxied by its GDP per capita, and its size, measured through population, capture the economic development stage and the national capacity to invest in research: both are found to be positively correlated to patent production (van Zeebroeck et al, 2009; Eaton and Kortum, 1996; Furman et al, 2002; Grupp and Schmoch, 1999).

Research effort seems to have a significant relevance in the propensity to patent abroad in terms of absolute R&D expenditures or as a ratio on the GDP (Eaton and Kortum, 1996; Chadha, 2009). However some studies[31] reported no significant impact of R&D intensity on patent propensity.

Other characteristics[32] which have been found in previous literature to affect the propensity to patent abroad are total stock of knowledge (Furman et al, 2002), level of the investments in education (Eaton and Kortum, 1996; Furman et al, 2002; Grupp and Schmoch, 1999; Varsakelis, 2006) and firm size[33] (Blind et al, 2006; Kortum and Lerner, 1999; Hanel, 2006).

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[31] A wide review of literature is in the work of Lopez (2009).

[32] These drivers will not be directly considered in the regression analyses of this study.

[33] Even if it is not a unanimous finding, Small and Medium Enterprises (SMEs) seem to have less propensity to apply for patents. A country with an high percentage of SMEs could consequently have a lower propensity to patent. Moreover, large firms often belong to an international group or are multinational enterprises with a precise global IP strategy: their propensity to patent abroad is higher. Lopez's review (2009) lists several articles with different results on the influence of firm size on patent propensity.

3.4.2. JAPAN AND THE JPO

This second group of characteristics describes the attractiveness of the recipient country in terms of national macroeconomic features and variations in the cost of patenting.

Japanese consumption capacities are directly related to national wealth and market size which are measured through GDP per capita and population (Bosworth, 1984; O'Keeffe, 2005).

Another relevant aspect of any national IP system is the cost of patenting. The cost of an international patent sums up the application and other office fees, the translation and the local patent attorneys' consultancy. Even if in Duguet and Kabla (1998) cost does not seemingly have an influence on patent decisions, other works found the opposite result. Macdonald (2004) stated that one of the major constraints is the cost of patenting but the increased value of the patent can dwarf these costs. Ordover (1991), Eaton and Kortum (1996), Watanabe et al. (2001), Yang and Kuo (2008) pointed out that a high cost can retain some applicants from patenting. Recently, de Rassenfosse and van Pottelsberghe de la Potterie (2009) found a negative elasticity in patent propensity when fees are raised.

3.4.3. EXTENDING COUNTRY – JAPAN RELATION

The propensity to apply for a patent in a foreign country is related to the level of economic involvement of a certain country in the recipient one and to their proximity. Proximity is meant not only in terms of spatial distance, even if some studies found it to be significant (MacGarvie, 2005; Perkins and Neumayer, forthcoming) but also in terms of technological closeness (MacGarvie, 2005), economic involvement and IP systems harmonisation (Kumar, 1996).

Patenting activities are related to industrial sectors[34]. If the extending country shares with the recipient country a particular specialization in certain sectors, this should imply a higher propensity to patent in that country. Eaton and Kortum (1996)

[34] Macdonald (Macdonald, 2004) and Kanwar and Evenson (Kanwar and Evenson, 2009) highlighted the role of pharmaceutical firms while, in Blind et al. (Blind et al, 2006) sector differences are said to be not so relevant.

stated that this can be viewed as the likelihood that inventions from the source can be adopted into the destination's technologies. This aspect will be investigated through different analyses in the next paragraphs.

The economic involvement in the recipient country may have a significant role in the number of patents a foreign nation files in. The involvement, that is the extent to which the production and the markets of any two countries are related, can be seen through the level of exports and of Foreign Direct Investments (FDI).

In reference to the work of Krugman (2009), international trade is one of the aspects defining the economic involvement of the extending countries in the recipient. A higher amount of exports to a particular country implies a greater variety of transferred technologies, for which patent protection must be sought, and therefore a greater number of international patent applications. The role of trade in explaining the variations in the number of international patents has been treated in Bosworth (1984), Grupp and Schmoch (1999), O'Keeffe (2005) and Yang and Kuo (2008). The ownership of proprietary technology potentially provides firms wishing to export their products and services with a competitive advantage in foreign markets. Exporters are expected to attempt to protect their technology in foreign markets by requesting patent protection. Without patent protection, domestic competitors (as well as third countries operating in the same market) could well engage in copy-cat engineering, eroding a firm's core competitive advantages and causing significant commercial damage.

Similarly, higher inward stocks of FDI suggest greater foreign involvement in the host economy, bringing with it a larger number of proprietary technologies, which again is likely to lead to more filings by non-residents. Some studies which found a significant positive correlation between international patent applications and FDI are those of Bosworth (1984), Kumar (1996), Hoekman et al. (2004) and Yang and Kuo (2008). As outlined in models of strategic blocking, FDI may additionally be accompanied by attempts to "build walls" around foreign markets, with a view to deterring the entry of other competitors. Multinational enterprises may file for a large number of patents in particular technology fields, whether or not they intend to use or licence the technology, in countries where they operate. They may also file for patents in the host economy to facilitate interaction, transactions and co-operation with other firms.

Evaluating at the same time exports and FDI could be problematic, since they are not independent. It is not clear if trade and FDI, as noted in Maskus (1998), are substitutes or complementary. In addition, Maskus (1997) remarks that Japan in relation to its GDP is a very small recipient of inward FDI but a large supplier of outward FDI.

Other characteristics[35] related to economic involvement which have been found in literature to have an influence in propensity to patent abroad are the number of collaborations and joint ventures (Hanel, 2006; Ma and Lee, 2005) and researcher exchange (Eaton and Kortum, 1996).

According to Ordover (1991) and Maskus (1998) IPR strength and an adequate level of protection and enforcement have a positive effect on the capacity to attract international patents. Similarly, Kumar (1996) found that an increasing IPR strength attracts more R&D only from industrialized countries.

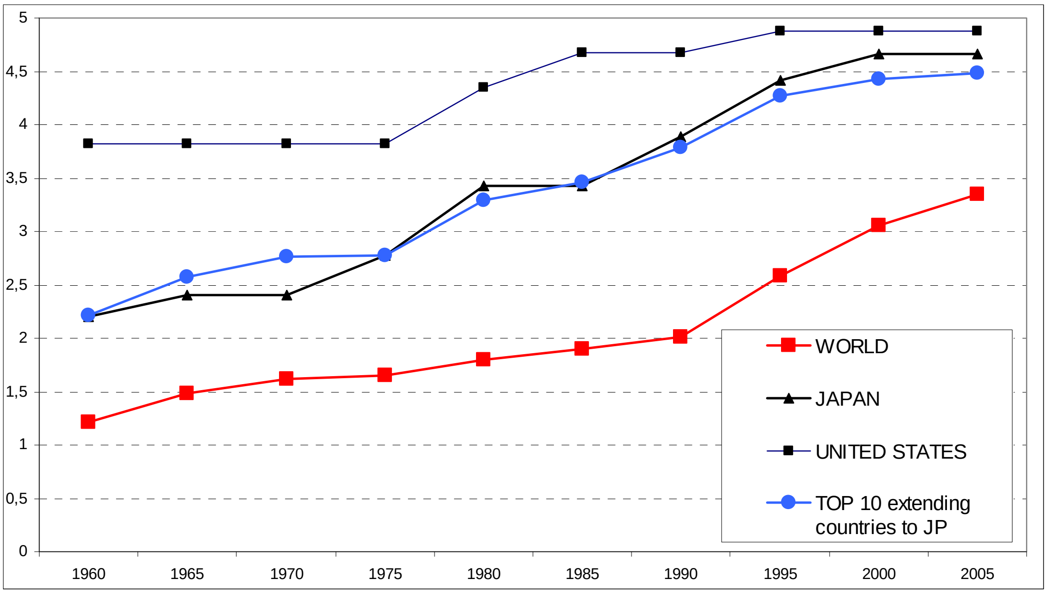
The strength of an IP system has been defined and measured in different ways. Maskus (2000) analyses some Patent Protection Indexes (PPI). Some of them are based on surveys such as the one in Lee and Mansfield (1996), Furman et al. (2002) or Porter and Schwab (2009): they try to estimate the IPR strength which is perceived by firms. Another type of measure includes the one defined by Rapp and Rozek (1990) and the one by Ginarte and Park (1997). They are based on a set of objective criteria.

The index realized by Ginarte and Park (1997) and recently updated by Park (2008) evaluates the level of patent protection and covers the longest period of time for the largest number of countries: for these reasons we refer to it in our analyses. Their Patent Protection Index (PPI) is made of five components, each scoring from 0 to 1. The five parts are: patent coverage in terms of allowed patentable subjects, maximum length of a patent, membership in international treaties, enforcement and loss of rights. They calculated each country's PPI every five years starting from 1960

[35] These drivers will not be directly considered in the regression analyses of this study.

until 2005. Figure 6 shows the variation of the index through time. Japan is below the U.S., which has the highest level, but it is reducing the gap. By contrast, even though the world average is increasing, the gap from Japan has increased. If the top 10 applicants to the JPO are considered, their average shows similar movements to Japan's PPI.

Figure 6 Patent Protection Index (World average, Japan, U.S. and top 10 non resident applicants at the JPO)



The joint analysis of trade flows from Japan towards the countries applying for patents at the JPO and the level of PPI in each of those nations might suggest an influence of such characteristics in the number of applications filed in Japan. When one country's patent system is not so strong as the Japanese and the volume of imports from Japan is high, it would be reasonable to expect that companies from those countries might decide to apply for patents in Japan with the aim of hindering competitors' activities in the market where patent protection is stronger, by setting patent fences in the Japanese market, origin of the imported goods.

3.5. METHODOLOGY

The dependent variable is the number of patent applications filed at the JPO from each country every year from 1991 to 2005[36]. Since the count of filings can assume only positive integer values and it is affected by overdispersion (variance largely exceeds mean), we decided to use a negative binomial model for panel data. In order to take into consideration the country specificities not investigated through explicit variables, we opted for a fixed effects regression[37].

The independent variables try to capture the main characteristics of the three groups mentioned in the previous section. If not otherwise specified, data are extracted from the Structural Analysis (STAN) database by the Organisation for Economic Co-operation and Development (OECD)[38] or from United Nations (UN) databases[39] and the currency unit is expressed in constant U.S. dollar.

In order to evaluate extending country characteristics, population (POP) and GDP per capita (GDPPC) stand for proxies of the size and the development level. The commitment to R&D is expressed by the gross expenditures on R&D as a ratio of the GDP (GERD[40]). These three variables are expected to have a positive influence on the number of international patents. To control for IP peculiarities of the extending countries, patent protection (measured through PPI[41]) and propensity to patent abroad (PROP) are considered. The latter has been calculated as the sum of one country's applications at the EPO and patent grants at the USPTO, both by date of filing.

The Japanese market is described through its population (POPJ) and its GDP per capita (GDPPCJ). The IP system proximity between Japan and each country or the level of harmonisation of patent protection is captured by the variable HARMON which is calculated as the absolute value of the difference between Japan's and each

[36] Data have been collected from several editions of the JPO Annual Report.

[37] The selected model implies restricting in the analysis to only those countries which have applied for at least one patent application in the considered period.

[38] Available online: http://stats.oecd.org/wbos/Index.aspx?DatasetCode=STAN08BIS&lang=en (last access on November 2009).

[39] Available online: http://data.un.org (last access on November 2009).

[40] Since in some years data are missing, it has been linearly interpolated.

[41] Since it is originally calculated only every five years, it has been linearly interpolated.

country's PPI. Since it is an absolute value, its effect is expected to be negative, that is the lower the PPI distance between Japan and the extending country, the higher the number of international filings. Finally, a proxy for the cost of patenting is represented by EFEE, that is the entry fee an applicant has to pay when deciding to apply for a patent at the JPO[42].

The last set of variables tries to describe the economic involvement of one country in Japan, through the volume of export (TRADE) and the inward FDI[43] (FDI), controlling by the technological distance (TECHD). The latter variable has been calculated[44] by considering one country's EPO applications broken down by the 8 main IPC classes (first digit). Each class can be considered as one dimensional axis where positioning each country. The ratio of each IPC class patents on the total number of applications filed by that country represents the country positioning on one of the 8 axes. Each country can be positioned in the 8-dimensional technological space and it is possible to evaluate how "far" it is from Japan in terms of Euclidean distance. Countries which are technologically closer to Japan are expected to file more applications at the JPO.

The effect of a weak patent protection in the case of a high level of imports from Japan in the analysed countries is captured by the combined variable EXP_PPI, resulting from the volume of exports from Japan to that country times the value of PPI: since it might be the case that companies decide to hinder competitors in a foreign market where PPI is higher, we expect a positive correlation with the number of filings to the JPO.

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[42] Data have been provided by de Rassenfosse and van Pottelsberghe de la Potterie (2009) and correspond to the yearly average entry fee paid by an applicant at the JPO.

[43] Data are collected from OECD's STAN database and from the statistics page available in the website of Japan Ministry of Finance of Japan: http://www.mof.go.jp/english/files.htm (last access on November 2009).

[44] We tried to calculate the technological distance by comparing the trade flows in classes of goods for which patent protection is particular relevant. In reference to the data in the OECD STAN Database and classified according to the Harmonised System 1992, we considered the following HS codes: 30 (Pharmaceutical products), 84 (Nuclear reactors, boilers, machinery, etc), 85 (Electrical, electronic equipment), 86 (Railway, tramway locomotives, rolling stock, equipment), 87 (Vehicles other than railway, tramway), 88 (Aircraft, spacecraft, and parts thereof), 89 (Ships, boats and other floating structures), 90 (Optical, photo, technical, medical, etc apparatus), 94 (Furniture, lighting, signs, prefabricated buildings), 95 (Toys, games, sports requisites). Unfortunately, the number of observations was too low to perform a robust econometrical analysis, thus the results are similarly pointing in the same direction.

Table 1 provides descriptive statistics of the mentioned variables.

Table 1Descriptive statistics of variables

Variable	Obs	Mean	Std Dev	Min	Max
Foreign patent applications	2494	307.376	1833.513	0	26026.000
Population (Million inhabitants)	2738	37.256	134.229	0.009	1321.052
GDP per capita (Millions constant USD)	2466	7523.010	9477.003	43.858	55807.570
GERD (percentage of GDP)	1029	1.163	0.963	0.016	4.762
Patent protection index (PPI)	1553	2.926	1.085	0	4.875
Propensity to patent abroad (Thousands of patents at EPO and USPTO)	2626	1.124	8.493	0	134.980
Population of Japan (Million inhabitants)	2757	126.173	1.439	123.205	127.762
GDP per capita of Japan (Millions constant USD)	2757	36221.560	2170.275	31719.330	40820.270
Entry fee (Thousands constant USD)	2757	0.123	0.036	0.077	0.195
Harmonization of patent systems (absolute difference in PPI)	1553	1.537	0.980	0	4.467
Trade (volume of export to Japan from each country - Millions constant USD)	2681	2528.083	8271.802	0	106038.600
FDI (Millions constant USD)	919	187.760	1076.590	-6322.638	22083.780
PPI * volume of import from Japan to each country	1553	17260.760	65071.940	0	701131.800
Technological distance	2757	0.432	0.254	0	1.132

The presence of possible industry specificities is evaluated through the variable measuring technological distance. Nevertheless, additional analyses were performed with the aim of capturing the relevance of potential propensities to file applications in certain fields in Japan: they will be carried out under a twofold perspective.

First, we will include in the econometric regressions specific control variables representing each country's technological specialisation, that is the number of direct applications in each IPC section at the EPO originated from the corresponding country in order to interpret results taking into consideration country technological specificities.

Second, we will test if there are differences in the shares of patent filings in the two patent offices, the EPO and the JPO, on the base of the number of applications in each IPC section for a selected sample of countries, the top ten countries by number of filings at the JPO, in three years: 1995, 2000 and 2005. This could provide evidence on the patenting behaviours of a sample of countries in the two patent offices.

Finally, anonymous referees suggested to us that the closeness of China to Japan might have an influence on the decision of large international corporations of filing patents at the JPO. Japan is indeed one of the few countries which have had trade surpluses with China for some types of goods which are particularly pertinent to patent protection[45]. Moreover, the presence of such a large and increasingly relevant market which has seen its PPI increase dramatically in the considered interval (it doubled from 1995 to 2005), might have affected the decision to file at the JPO in order to sustain patent filings in China, where the PPI was not so high in the 90's. To investigate the relevance of such a possible factor, the regression results on the importance of the variable combining trade and PPI will provide a first general suggestion and a specific analysis on the filing strategies at the Chinese Patent Office (SIPO) will be carried out to add more detailed evidence to the results.

3.6. RESULTS

The regression results are shown in Table 2: the number of observations is different across the models because of data availability. In particular, data on R&D expenditures (GERD) and FDI are not traced for all the countries and years studied in this work.

The set of variables which describes origin countries shows significant positive values in terms of size (measured through population) and commitment to R&D

[45] An analysis of the flows between Japan and China (data extracted in may 2010 from OECD Structural and Statistical Analysis Database, when Japan is the reporter country and based on the Harmonised System 1992) revealed notable trade surpluses for Japan in the following HS codes: "Vehicles other than railway, tramway" (HS87) and "Optical, photo, technical, medical, etc apparatus" (HS90). More trade surpluses were found, even if limited to certain years, also for the following HS codes: "Pharmaceutical products" (HS30); "Nuclear reactors, boilers, machinery etc." (HS84); "Electrical, electronic equipment" (HS85); "Railway, tramway locomotives, rolling stock, equipment" (HS86); "Aircraft, spacecraft, and parts thereof" (HS88).

(GERD) when the econometrical analysis is run considering either only this type of variable or all the variables. The development level, proxied by the wealth of country population (GDPPC) loses relevance when all the variables are considered but it still keeps a positive sign. The PPI of the extending countries proves positive significance. It is worth noting that in the regression, the propensity to patent abroad (PROP) is taken into consideration but it is not relevant.

Table 2 Panel data - Negative binomial - Applications at the JPO per country per year

Model	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Observations	671		584		468		453		468		453		453	
Population	0.009	***			0.003	***	0.009	***	0.003	***	0.002	***	0.002	***
GDP per capita	0.020	***			0.014		0.002		0.014		0.019	*	0.016	
GERD	0.540	***			0.453	***	0.548	***	0.453	***	0.482	***	0.490	***
Patent protection index	0.350	***												
Propensity to patent abroad	-0.001				0.001		-0.467		0.001		-0.001		-0.001	
Export from Japan * PPI													0.001	
Population of Japan					0.016		-0.003		0.012		0.037		0.044	
GDP per capita of Japan					0.046	*	0.067	***	0.048		0.035		0.033	
Entry fee									0.079		0.149		0.101	
Harmonisation of patent systems			-0.675	***	-0.614	***	-0.322	***	-0.614	***	-0.565	***	-0.555	***
Trade (volume of export)			0.013	***	0.001		-0.001		0.001		0.005		0.003	
FDI			0.011		-0.006		-0.006		-0.006		-0.005		-0.005	
Technological distance			-0.928	***	-0.594	*			-0.592	*				
Control variables on technological specialisation (applications at the EPO broken down by IPC section)	yes						yes				yes		yes	
Constant	-0.676	**	2.286	***	-2.137		-0.820		-1.760		-5.132		-6.039	

The set of variables inherent in the recipient Office and Japan seems less relevant with the only exception being the level of harmonisation of the IP system. The size of market, that is the Japanese population, (POPJ) and its consuming capability (GDPPCJ) have a positive sign but are not significant (only in 2 cases GDPPCJ is relevant). The entry fee (EFEE) does not show significance[46] while, on the contrary, the difference in PPI between Japan and each of the extending countries (HARMON) proved a robust negative sign: the more similar the IP systems are when measured through the PPI, the higher the number of patent application extended from that country to the JPO.

The variables specifying some of the interactions between Japan and the rest of the world are less relevant. The technological distance (TECHD) is relevant with a negative sign, that is the closer the extending country and Japan are in terms of patented technology, the higher the number of filings is from that country to the JPO. A complementary control for the technological specificities of the extending countries is provided by the variables built on the number of applications in each IPC section filed in at the EPO: results are robust when considering also this group of variables.

Trade volumes (TRADE) and FDI report coefficient which are not significant (only in one case for TRADE while FDI presents changing sign) but it must be remembered that compared to other highly industrialized countries volumes of trade and FDI are quite low.

Concerning the combined effect in each origin country of a domestic weak patent protection index and of a high volume of imports from Japan, the resulting coefficient is not significant, suggesting that the analysed factor, in our data set, has not such a strong impact on the number of applications filed at the JPO: companies from countries with a lower PPI and a high inward trade flow from Japan are not systematically filing applications at the JPO to hinder importing firms.

[46] We performed other tests including entry fee variable in combination with other set of characteristics and reaching the same result.

3.6.1. INDUSTRY SPECIFICITIES

The presence of possible sector specificities is taken into account through the technological distance between extending countries and Japan and the number of filings at the JPO and through the set of variables measuring the technological specialisation of origin countries by their patenting activities at the EPO in each IPC section.

In order to investigate in more detail the relevance of technological specificities, we performed further analyses on the differences between the shares of patent applications in each IPC section in the two patent offices, the EPO and the JPO. For a subsample of patent offices[47], we performed chi-squared tests for three different years (1995, 2000 and 2005). The tests compared the proportions at the EPO and at the JPO and showed that they are statistically different in all the considered years. Detailed results are presented in Table 3 by directly comparing the shares and highlighting the differences across the IPC sections: percentages represent the comparisons between the share of applications at the JPO with those at the EPO in each IPC section; if the two shares are equal, then the cell value will be 100% while a value below 100% means that the EPO share is proportionally larger than the JPO one. From our analysis we can conclude that there are differences in the shares of patent applications at the level of IPC sections[48] and that the differences are related both to the destination office and to country specificities in reference to the IPC section of the applications. In the selected sample, some technological fields report a larger share of applications at the JPO from almost all the countries, correspondingly to the IPC sections A "Human necessities" (which includes among the others the class of pharmaceutical patents), B "Performing operations; transporting" and G "Physics" while the share is lower at the JPO for the IPC section H "Electricity". The comparison between the shares in the IPC section E, "Fixed constructions",

[47] The selected patent offices are the top ten institutions per number of patent filings extended to the JPO, namely the patent offices of: France, Germany, Italy, Republic of Korea, Netherlands, Sweden, Switzerland, Taiwan, United Kingdom and U.S.

[48] The eight IPC sections are: A "Human necessities"; B "Performing operations; transporting"; C "Chemistry; Metallurgy"; D "Textiles; Paper"; E "Fixed constructions"; F "Mechanical Engineering; Lighting; Heating; Weapons; Blasting"; G "Physics"; H "Electricity". Thus, economic industrial sectors might be represented in different IPC sections, they provide a first classification of patent applications.

highlights differences in every year for almost all the countries but it is largely due to the generally smaller values of shares in this class.

Table 3 Ratio (as percentage) of the JPO share to the EPO one in each of the 8 IPC sections for the top 10 foreign applicant patent offices extending applications to Japan in the years 1995, 2000 and 2005. Values are in bold where the difference is larger than one third. Values are smaller than 100% when the share at the EPO is larger than the one at the JPO.

Patent Office of origin	Application Year	IPC A	B	C	D	E	F	G	H
France	1995	**137%**	104%	94%	69%	**28%**	69%	128%	79%
	2000	**163%**	115%	80%	**58%**	**44%**	85%	117%	**64%**
	2005	132%	103%	**157%**	126%	**37%**	120%	82%	**62%**
Germany	1995	127%	121%	92%	125%	**30%**	99%	112%	68%
	2000	122%	120%	86%	**63%**	**33%**	111%	113%	73%
	2005	89%	102%	**147%**	93%	**32%**	102%	88%	93%
Italy	1995	**145%**	100%	**157%**	105%	**48%**	**58%**	79%	**55%**
	2000	**162%**	96%	125%	**54%**	**45%**	**62%**	93%	67%
	2005	120%	110%	**180%**	105%	**26%**	92%	67%	**43%**
Republic of Korea	1995	108%	121%	**58%**	95%	**62%**	**56%**	**201%**	92%
	2000	79%	123%	**64%**	**54%**	100%	**162%**	**134%**	91%
	2005	93%	111%	105%	**37%**	108%	78%	121%	95%
The Netherlands	1995	**141%**	**219%**	**39%**	**50%**	**37%**	**147%**	87%	**54%**
	2000	**147%**	**278%**	79%	81%	**61%**	**228%**	**48%**	**33%**
	2005	103%	**341%**	**48%**	85%	**142%**	**296%**	**34%**	**56%**
Sweden	1995	127%	117%	75%	90%	**54%**	78%	114%	77%
	2000	**143%**	**157%**	68%	111%	**60%**	107%	**149%**	**50%**
	2005	113%	117%	**157%**	**173%**	89%	110%	108%	**48%**
Switzerland	1995	104%	121%	118%	113%	**51%**	**54%**	106%	**52%**
	2000	87%	129%	93%	107%	**58%**	70%	**145%**	**58%**
	2005	84%	**141%**	100%	**201%**	80%	**173%**	70%	**46%**
Taiwan Patent Office	1995				n.a.				
	2000	**43%**	**58%**	133%	**56%**	**42%**	69%	**183%**	120%
	2005	**41%**	**47%**	104%	**42%**	**21%**	96%	**169%**	111%
United Kingdom	1995	**147%**	84%	87%	67%	**24%**	**61%**	118%	120%
	2000	**150%**	78%	70%	**53%**	**21%**	**52%**	**134%**	114%
	2005	95%	78%	**159%**	94%	**16%**	**65%**	103%	107%
U.S.	1995	109%	118%	73%	**59%**	**55%**	98%	129%	85%
	2000	112%	110%	**65%**	**61%**	**43%**	86%	**139%**	87%
	2005	96%	75%	114%	85%	**40%**	76%	107%	116%

The differences across the proportions are much more evident when considering only the European extending offices (A and B report higher share values at the JPO than at the EPO; the opposite for H) in comparison to the non-European ones, where it is the IPC section G, which appears as more relevant at the JPO than at the EPO and the section D, "Textile and papers", as reporting proportionally more applications at the EPO than at the JPO.

Taking into account the overall shares of foreign and Japanese domestic filings across the IPC sections[49], it emerges that the sections where the presence of foreign patents is more relevant are A (ranging from 17% of patent filings in 1991 to 27% in 2005), C (from 20% in 1991 to 28% in 2005) and D (around 20% in the whole period). The foreign applications in the E section are circa 5% of the total number of filings and the remaining IPC sections (B, F, G and H) saw their shares doubling from circa 7% in 1991 to circa 15% in 2005.

If we consider the fields where the Japanese companies file more patents[50], we can conclude that foreign companies generally submit more patents at the JPO in certain IPC sections in direct competition with Japanese patentees, as in the case of A, B and G sections, while seeming to avoid the confrontation on the H section where domestic companies are on the contrary particularly active and file abroad less than they do at the EPO. Thus, the results may vary accordingly to the origin country extending to the JPO in a particular technological field.

3.6.2. ROLE OF CHINA

The investigation of the relevance of China in the number of patent filings at the JPO has been carried out through different approaches. Since Japan reports trade surpluses with China for some types of goods which are particularly pertinent to patent protection and China has only recently started to strengthen its patent law, it might suggest that foreign companies could systematically file applications at the JPO to gain support for their corresponding patents in China. However, as mentioned

[49] Elaboration from data retrieved from the EPODOC database in July 2009 on the JPO patenting activities.

[50] From the elaboration of EPODOC, data showed that concerning the domestic filings: B, G and H are the sections with the largest numbers of domestic applications (jointly equal to 70% of the domestic filings, each reporting more than 80 000 applications per year); A, C and F sections are on a lower level (each around 40 000 filings per year, jointly 25% of domestic filings); finally E and D sections are represented by respectively around 20.000 and less than 10.000 applications per year (jointly around 5% of domestic filings).

previously, the variable taking into consideration both the PPI and the volume of trade from Japan to each origin country is positive but not significant[51].

Furthermore, the analysis of the number of patent applications at the SIPO[52] reporting a first priority in the U.S. or in any European member states and at the same time presenting a Japanese priority, allow us to reject the hypothesis that U.S. and European companies looking for protection in China apply at the JPO in order to strengthen the corresponding filings in China. We found only 267 Chinese applications from 1991 to 2005 with first priority in U.S., at the EPO or in any European Patent Convention member state, and reporting at the same time a priority in Japan. That value corresponds to around 0.10% of the total number of Chinese patent applications with a priority in U.S. or in Europe. By way of example, Table 4 reports statistics for Chinese patents with a first U.S. priority for the years 1995, 2000 and 2005 broken down by patent kind code. According to the retrieved data, U.S. patentees decided to declare the previous extension to the JPO as one of the priority of their Chinese patents in very few cases: 0.14% in 1995, 0.10% in 2000 and 2005. According to our analysis we can conclude that it is not possible to identify a systemic influence exerted by the closeness of China to Japan on the decision of submitting a patent filing in Japan by companies from any other country[53].

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[51] In the corresponding table showing regression results, only some analyses are reported. However, the variable EXP_PPI has been tested in different regressions reporting no significant correlation with the number of patent filings at the JPO.

[52] Elaboration from Thomson Innovation, data downloaded in May 2010.

[53] This behaviour is confirmed by the anecdotal evidence provided by a European patent examiner collaborating with the SIPO. He deems the proposed behaviour of foreign applicants supporting Chinese filings with Japanese patents more particular than general and, in his experience, until recently in case of litigations a Chinese utility model was much more significant than any foreign patent in the eyes of a Chinese Judge. Basically, foreign companies in China found it more effective to apply for a simple utility model (cheap and requiring no examination) than trying to negotiate on the basis of foreign patent documents.

Table 4 Number of patent documents applied at the SIPO reporting US as first priority country (column 1) and also extended to the JPO (column 2 reports the amounts and column 3 the percentages on the values in column 1) in years 1995, 2000 and 2005. Values are presented broken down by SIPO kind codes.

year	1995			2000			2005		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Kind Code:									
A OPI application	4581	5	0.11%	4583	4	0.09%	6008	6	0.10%
Y Examined application	33	0	0.00%	63	0	0.00%	66	0	0.00%
C Granted	2717	5	0.18%	2621	3	0.11%	1149	1	0.09%
Total	7331	10	0.14%	7267	7	0.10%	7223	7	0.10%

3.7. CONCLUSION

This Chapter aims to provide some insights into the reasons for the recent increase in foreign patent applications at the JPO. The investigated variables can be grouped in different classes: macroeconomic values related to the extending countries and to Japan, patent system indexes and data on each exporting nation about its involvement in and proximity to the recipient country.

The characteristics of the extending countries which seem to positively affect the number of patent applications per year are mainly the size, the commitment to R&D and the strength and coverage of the domestic patent system, respectively proxied by population, gross expenditures on R&D and the Ginarte and Park patent protection index (Ginarte and Park, 1997; Park, 2008). Less robust but still positive coefficients result from the analysis of extending countries' wealth, measured through GDP per capita. The propensity to patent in Japan is therefore related to the innovativeness of each origin country: when domestic investments in R&D grow and the domestic patent system reaches a higher level of PPI, the number of patent applications to the JPO rises, likely to be a direct consequence of a general increase in the number of patent filings in the origin country.

When the focus is set on the characteristics of the recipient Office and Japan, neither the size of the market nor its wealth, respectively measured through population and GDP per capita, report a significative coefficient. The proximity of the patent system to that of the extending country seems to facilitate the patent extension procedure: the harmonisation of national patent systems in this sense play a facilitating role in the flow of patents from one country to another. The level of harmonisation is measured in terms of distance between the PPIs. The patent fee does not present significative coefficients[54].

The involvement of each extending country in Japan, accounted by FDI and trade volumes, does not report a clear correlation with the number of filings at the JPO. It is worth remembering that inward flows of investments are low compared to other industrialized countries and so even small variations in the yearly amounts can change the trend of FDI. Moreover, the same FDI data are not available for all the countries in all the years considered.

Deeper analyses have been carried out in order to control for particular technological specificities and to highlight possible systemic trends. Regression results have been controlled for technological distance between Japan and the extending countries and for the levels of the shares of applications at the EPO in each IPC section. Moreover, the analysis of a sample of ten extending patent offices in 1995, 2000 and 2005 showed that from the comparison of the proportions in the IPC shares at the JPO and at the EPO significant differences have been found. Reasons for such dissimilar behaviour seem partly connected to the destination market, being Japan or Europe in this case, and partly to country sectoral specificities.

Finally, the supposed influence of China in the patenting behaviour of foreign companies in Japan does not appear relevant from the recorded patent documents subject of the analyses in this study.

Future research may clarify the role of the variables considered by extending the number of recipient offices and increasing the number of observations by gaining more data on variables such as R&D expenditures and FDI.

[54] It is worth remembering that the values used in the analysis are calculated as average of all the filings at the JPO: since they include both domestic and foreign patents, they can be affected by some distortions.

4. INTERNATIONAL PATENT ACTIVITIES: PATENT EXPORT FROM EUROPE, USA, JAPAN, CHINA, SOUTH KOREA, INDIA, BRAZIL, MEXICO AND RUSSIA

4.1. INTRODUCTION

International relationships regarding IPR systems, innovative activities and R&D are important components of the globalisation process. The analysis of patenting activities in advanced OECD countries allows to better understand national IPRs systems and, by doing so, the relationships between advanced and emerging economies.

Across countries, patent applicants' interest to export in targeted nations is depending on several reasons such as historical grounds as well as geographical boundaries. In addition, internationalisation of operational business and Foreign Direct Investments (FDI) certainly play a determinant role. Nonetheless, this does not seem to cover the complete picture. According to data on patent applications or granted patents, there is indication of a high variation in the patent export of the Trilateral Offices towards emerging economies such as Mexico, South Korea, Brazil, etc. Furthermore, variations over time of such dynamics seem to be interesting to monitor, especially in light of the emergence into the international scene of Patent Offices (POs) of rapidly growing countries, such as China.

In this Chapter we aim at extend the previous analyses of Chapter 3 by including more POs and considering cross country flows of patent applications. Such analyses will allow us to draw conclusions on the relevance of selected drivers, such as macroeconomic characteristics and harmonization of patent protection systems, on the growth of foreign patents, and hence to analyse in depth the available export patent data in order to investigate possible reasons behind tighter or looser exchange relationships between countries. Since the rationale, the scientific background and the methodology have already presented exhaustively in the previous Chapter we will provide additional explanations only in reference to the peculiarities of this extended study.

4.2. INTERNATIONAL PATENTS: RELEVANCE AND DRIVERS

Building upon the previous Chapter 3[55] in order to extend the conclusions to the case of multiple POs, we aim to highlight some of the characteristics of the international patents which are relevant when considering more than one recipient PO and in particular when the involved countries are at different stages of development.

Concerning the level of protection guaranteed by the national IP system, according to Ordover (1991) and Maskus (1998) IPR strength and an adequate level of enforcement have a positive effect on the capacity to attract international patents. Similarly, Kumar (1996) found that an increasing IPR strength attracts more R&D but only from industrialized countries. The strength of an IP system has been defined and measured in different ways (Maskus, 2000): our study will make use of the Patent Protection Index (PPI) defined by Ginarte and Park (1997), based on a set of objective criteria and calculated for all the countries subject of this study.

PPI is used to evaluate the distance between POs in terms of patent systems in force in the corresponding countries. The absolute difference between the PPI in the destination country and in the origin will be considered as the level of patent system harmonization between those two nations. It is expected to have a positive effect on patent export since patent applicants should benefit from the legal proximity and from their expertise in similar procedures thus in different POs.

Additionally, in order to better understand the importance of membership in an international agreement, some relevant treaties are considered: Paris Convention for the Protection of Industrial Property (from March 20, 1883); Strasbourg Agreement Concerning the International Patent Classification (from March 24, 1971); Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure (from April 28, 1977). The access to such agreements

[55] In particular the sections 3.2 and 3.3.

is expected to increase the patent flows both inward and outward especially when the considered partner countries have joined the same treaty.

The existing literature has identified several drivers to the growth of international patent applications and they have been discussed in the previous Chapter: we report here only the most relevant features related to a multi-PO approach.

- Extending country characteristics: The wealth of a nation, proxied by its GDP per capita, and its size, measured through population, capture the economic development stage and the national capacity to invest in research: both are found to be positively correlated to patent production (van Zeebroeck et al., 2009; Eaton and Kortum, 1996; Furman et al., 2002; Grupp and Schmoch, 1999). Research effort seems to have a significant relevance in the propensity to patent abroad in terms of absolute R&D expenditures or as a ratio on the GDP (Eaton and Kortum, 1996; Chadha, 2009). However some studies[56] reported no significant impact of R&D intensity on patent propensity.

- Recipient country characteristics: This second group of characteristics describes the attractiveness of the recipient country in terms of national macroeconomic features and variations in the cost of patenting with the corresponding variables mentioned for the origin country, that is; size and wealth through population and GDP per capita in order to evaluate the consumption capacities which are directly related to national wealth and market size (Bosworth, 1984; O'Keeffe, 2005).

- Extending – recipient country relation: The propensity to apply for a patent in a foreign country is related to the level of economic involvement of a certain country in the recipient one and to their proximity. Proximity is meant not only in terms of spatial distance, even if some studies found it to be significant (MacGarvie, 2005; Kumar, 1996) but also in terms of patent systems harmonization as described above (Kumar, 1996). The economic involvement in the recipient country may have a significant role in the number of patents a foreign country files in. The involvement, that is the extent to which the

[56] A wide review of literature is in the work of Lopez (2009).

production and the markets of any two countries are related, can be seen through the level of exports and of Foreign Direct Investments (FDI)[57]. Evaluating at the same time exports and FDI could be problematic, since they are not independent. It is not clear if trade and FDI, as noted in Maskus (1998), are substitute or complementary. Finally an indication of distance is included among the control variables. We opted for a dummy variable describing whether each pair of countries have shared boundaries (including sea boundaries) or not, instead of using the distance in kilometres between the capital cities because it could have been misleading in the case of Moscow and the number of POs is limited.

4.3. METHODOLOGY AND DATA COLLECTION

4.3.1. INFORMATION ON PATENT SYSTEMS

In order to describe the different patent protection systems in force in each country considered in this study, some key figures have been collected and represented by indexes, proxies and dummy variables. Table 5 reports all the considered variables relating to patent system features and applied in the following analyses. The main sources for this type of data are the article by Ginarte and Park (1997) and the WIPO online databases.

Table 5 List of the features describing the patent systems of the analysed countries considered as possible drivers to patent export.

Variable – Driver	Unit of measurement
Ginarte and Park Index	From 0 to 5
Total PCT filings per country of origin (Based on first applicant's nationality)	Number per year
Total PCT filings per destination office	Number per year
Paris convention: signature year	Dummy equal to 1 from the accession year
Budapest Treaty: signature year	Dummy equal to 1 from the accession year
Strasbourg Agreement: signature year	Dummy equal to 1 from the accession year

[57] The role and the importance of trade and FDI have been more extensively tackled in the previous Chapter 3.4.3.

The main variable used to describe the patent protection systems of the selected countries is the Ginarte and Park index which evaluates the level of patent protection in single countries: data are available in the corresponding paper (Ginarte and Park, 1997)[58] and on request from the authors. Their Patent Protection Index (PPI) is made of five components, each scoring from 0 to 1: patent coverage in terms of allowed patentable subjects, maximum length of a patent, membership in international treaties, enforcement and loss of rights. They calculated each country's PPI every five years starting from 1960 until 2005. In this study, the PPI for the EPO has been calculated as average of the indexes of the EPC member countries, weighted on their GDP.

The WIPO website is the source of the remaining data: the yearly number of PCT filings originated from each country and submitted in each destination office[59] and the group of dummy variables providing information on the agreements and treaties each office has signed[60].

4.3.2. MACROECONOMIC AND STRUCTURAL DATA

Macroeconomic and structural data are extracted from the official databases of two international organizations: the Organisation for Economic Co-operation and Development (OECD) and the United Nations (UN). Table 6 sums up the variables which are part of the analyses. All the data concerning the EPO, as aggregate of its member countries, have been treated with the same methodology described for EPO patents in the correspondent Appendix 8.2.

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[58] Recently updated by Park, 2008. Please refer to Chapter 3 for additional details on such variable.

[59] Data were downloaded in February 2010 from http://www.wipo.int/ipstats/en/statistics/patents/index.html .

[60] Available here: http://www.wipo.int/treaties/en/ .

Table 6 List of the macroeconomic and structural variables, with corresponding unit of measure, considered as control drivers to patent export.

Variable - Driver	Unit of measurement.
Trade: Export	Million USD
Trade: Import	Million USD
GDP per capita	USD (PPPs)
Gross domestic expenditure on R&D	Percentage of GDP
Total population	Million inhabitants
FDI: inward flow	Million USD
FDI: outward flow	Million USD

OECD's STAN has been used as source for most of data variables[61]. The data collection reports information mainly on OECD members: for this reason, some data about China, Brazil and India are missing and it is especially relevant when the searched data involves two of those countries: for instance, in the case of FDI from China to India and vice versa.

UNData is a comprehensive source which aggregates most of the data collections administrated by the UN Statistical Division and the World Bank. We made use of such database as an additional resource to reduce the number of missing data which the OECD's database could not provide: most of the missing records are about FDI and trade volumes for the non-OECD countries. In particular, the downloaded subsets of data come from the Commodity Trade Statistics Database (ComTrade) and from UNCTAD countries factsheets[62].

4.3.3. PATENT DATA

Differently from the data analysed in the previous Chapter, which were extracted from the JPO Annual Report, patent information have been collected directly from one of the EPO databases, directly accessed at the Den Haag site of the European Patent Organisation in July 2009. Data have been extracted from EPODOC database

61 Data downloaded in February 2010 from: http://stats.oecd.org/wbos/Index.aspx?DatasetCode=STAN08BIS&lang=en .

62 In February 2010 data were downloaded from http://comtrade.un.org/db/ and the country factsheets of Brazil, Mexico and Russia from http://www.unctad.org/ .

which records patent publications from all over the world. The basic unit of this analysis is the individual patent application filed in one of the POs considered in the project. The application code is a unique key in EPODOC database and allows to identify the PO where the application was filed in and the submission date. EPODOC records include patents and utility models, also known as “petty patents”.

EPODOC data are based on those provided by the World POs which have their own peculiar procedure to store and publish patent data and in some cases have changed over time. Similarly, the various world POs report data to EPO with no commonly defined scheme in terms of format and timing. The reasons and the magnitude of these structural limits are not always clearly evident but whenever they have been recognized in this study, they have been highlighted[63].

4.3.4. IDENTIFICATION OF ORIGIN COUNTRIES: PRIORITIES

The origin country of a so called “international patent” can be identified through some methods based on different patent information: priority countries, applicants’ or inventors’ nationalities. A patent (granted or pending approval) can be defined as “international” when it reports at least one priority in another PO belonging to a different country. An alternative definition makes use of information on the assignees whose nationalities are not the same of the examining and granting office. Since in most of the cases[64], the applicants, that is the patent rights owners, decide to file the application in the country they reside in and to extend later the patent in all the countries they have interests to gain protection, the two definitions can be considered overlapping. In other cases, international patents may be defined as such on the basis of the nationality of the inventor, rather than the assignee. In this case, any patent applied for in country A in order to protect an invention by an individual (inventor) from country B can be defined as international.

[63] Since there is no common pattern in the process of gathering data, some discrepancies emerged and they are more extensively described in the corresponding Appendix 8.2.

[64] van Zeebroeck et al. (2009), analyzing a dataset of one and a half million EPO applications filed between 1982 and 2004, found that a little more than 3% of the applications are filed in by non-US applicants thus reporting a US priority, and about 1.5% of applications are submitted by a US applicant with a non-US priority.

During the preliminary data collection phase of this study, patent information were collected according to two main criteria in order to trace the flow of patent applications from one country to another: the origin country of an application was identified by its applicants' nationalities or its priority countries. When considering the applicants' nationalities, anyhow, some technical problems emerged. Unfortunately different POs have different procedures to store applicants' information and to transfer data to the EPO database, so it has not been possible to identify applicants' country of residence with the same accuracy for all the analysed POs. For such reason, the approach through this kind of data has been suspended and the next analyses are based on the rule of priority filings in order to identify origin countries. The POs of the priority filings are considered as the origin of that patent application.

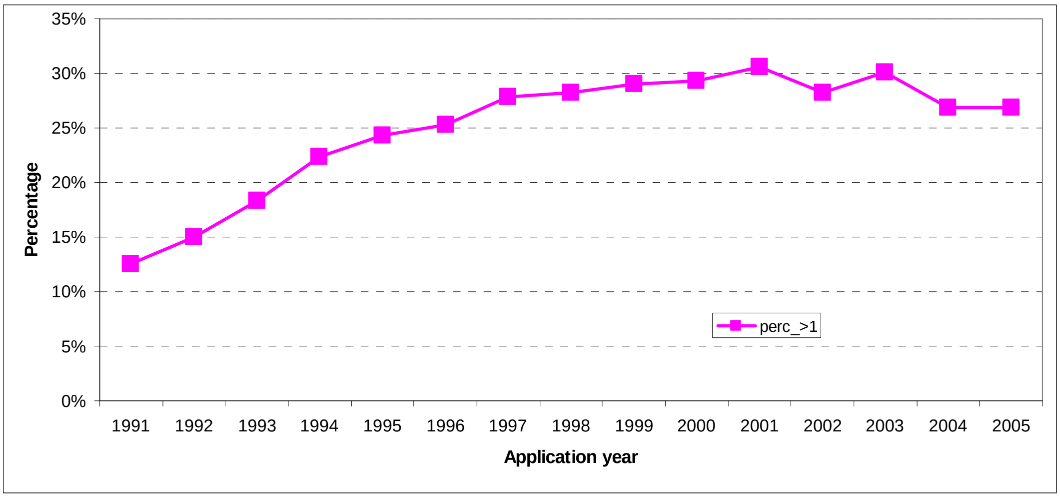
In this study, priority and application countries are considered respectively as origin and destination of patent flow. The import (or export) of patents from country "A" to country "B" refers to the amount of applications filed in at the recipient office in country "B" reporting a priority from the office in country "A". The same criterion is applied to identify domestic applications: if an application to the PO "A" has a priority from the same country "A", it is counted as a domestic filing.

4.3.5. LIMITATIONS OF THE METHODOLOGY

When a patent application has more than one priority and from several countries, each of them is counted as origin for the application. By way of example, if a Japanese application (that is a filing at the JPO), filed in 1999, has two priorities, one at the USPTO and one at the KIPO, both the flows of patent applications in 1999 from US to Japan and from South Korea to Japan are increased by one. The result is that the same patent document is double-counted and increases two different flows.

As Figure 7 shows, most of the applications have only one priority. Starting from 1991 the share of applications with more than one priority rose from 12% to around 30% in 2000, and then stabilized below it in the following years (circa 26% in 2005). This should be considered a caveat for the next statistics: the data on the last years are based on patent counts which include more often than in the first years overestimated flows, due to the multi-priority issue previously mentioned.

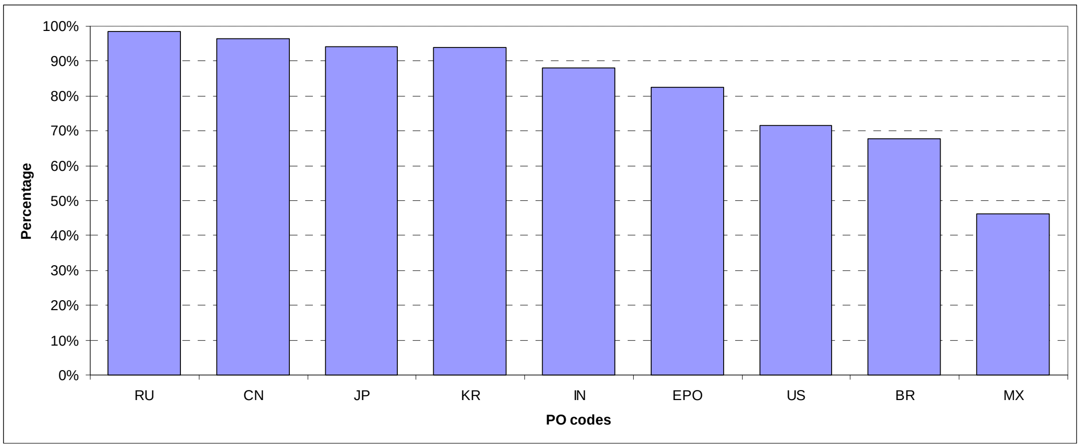
Figure 7 Percentage of world patent applications with more than 1 priority (1991 – 2005)



Limiting the analysis to the selection of countries and POs part of this study, the share of applications with only one priority in the whole period 1991 – 2005 is higher than 80%. Anyhow, the number of priorities per patent application differs across countries of filing (Figure 8): for instance, in the case of Mexico, more than half of the filings have more than one priority. The consequence is that for a country like Mexico, the inward flows of patent could be overrated in the analysis. However, these values, combined with the results of the Mexico specific analysis, suggest that Mexico PO receives a large share of patent application from foreign countries and probably at a later stage in the process of international extension.

This aspect would need a deeper investigation: by way of example, it could be worth to be explored whether many priorities for one patent are related to different countries or to the same, whether the patent application is the union of different patents from the same country or if it is a matter of data transfer to the EPO.

Figure 8 Percentage of patent applications with only one priority: application country breakdown (1991 – 2005)



Note: In this case, "EPO" includes all the filings at the EPO, with "EP" code in EPODOC, and at the member state POs according to the board of countries as of July 2009.

The previous breakdown replicated on priority countries (in Figure 9) shows similar results: seven of the nine POs, when considered as origin, have more than 80% of applications with only one priority. On the contrary, India and U.S. show lower values, suggesting that applications to any PO which originate from one of these two countries have, more often, more than a single priority. The data point out that the outward flows from India and U.S. might be overrated in this study.

The explanations are not immediate and should be deepened in a future research: the differences across countries could be due to different IP legal frameworks or rules; including U.S. among the priorities could have the expected effect to prove a stronger priority. Anyway, this is not the focus of the study.

Figure 9 Percentage of patent applications with only one priority: priority country breakdown (1991 – 2005)

Note: In this case, "EPO" includes all the filings at the EPO, with "EP" code in EPODOC, and at the member state POs according to the board of countries as of July 2009.

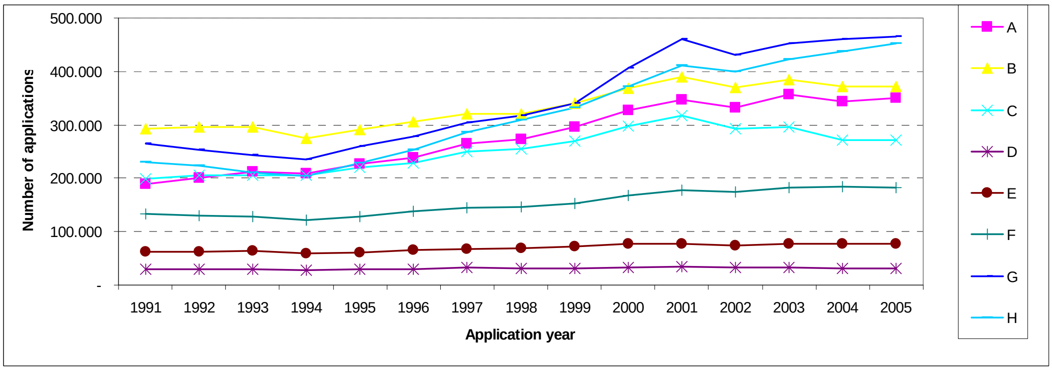
4.3.6. IPC ANALYSIS

Patent applications in EPODOC are classified according to the International Patent Classification (IPC). Different classes of patents extended from one country to another can be distinguished. In this study IPC codes are treated from a broad perspective by considering only the first digit, that is the eight IPC sections defined by letters from A to H and representing: A - human necessities; B - performing operations, transporting; C – chemistry, metallurgy; D – textiles, paper; E - fixed constructions; F - mechanical engineering, lighting, heating, weapons, blasting; G – physics; H - electricity.

Figure 10 represents the sum of patent filings of the nine POs broken down by IPC section in every year[65]. The largest increase in number of filings happened in the sections A, G and H. Applications belonging to B, C and F codes grew less and with different paths, while those belonging to E and D, which include mainly mature technologies, did not change much in the examined years.

[65] The procedure to collect this information from EPODOC was such that the results might be slightly overestimated due to multi-priority issue.

Figure 10 World patent applications, broken down by IPC section (1991 – 2005)



4.4. ECONOMETRIC MODEL

The dependent variable represents the patent flow from one PO to another: it is the yearly total number of patent applications filed at each of the nine POs of this study originated from each of the other eight POs (72 flows in total) from 1991 to 2005. Since the count of filings can assume only positive integer values, we decided to use a negative binomial model for panel data. In order to take in consideration possible missed differences among countries, we opted for a fixed effects regression.

The records reporting the flows towards India after 1994, towards Mexico from 1993 to 2001 and towards Russia before 1991 have been dropped for the reasons described in the previous paragraphs and more extensively in the related Appendix 8.2

The independent variables try to capture the main characteristics mentioned above in terms of patent system features by controlling for some key macroeconomic values. The patent system proximity between the POs involved in every flow or the level of harmonization of patent protection is captured by the variable calculated as the absolute value of the difference between the two countries' PPI. Since it is an absolute value, its coefficient is expected to be negative, that is the lower the PPI distance between the recipient and the extending country is, the higher the number of international filings is.

One of the five components of the PPI is based on the membership into international agreements, meaning that the PPI is correlated to the dummy variables of the agreements (Paris, Strasbourg and Budapest treaties). For this reason, they are treated separately in the regressions. Moreover, one of the analyses considers the contemporary membership of each pair of POs as product of the corresponding dummies: e.g. the corresponding variable is equal to 1 when both the origin and the destination countries are members of the Paris Convention, in all the other cases it is set to 0.

The variables which show the amount of PCT filings originated from and applied at a certain PO aim to evaluate the relevance of access the Patent Cooperation Treaty while considering also the yearly number of applications processed through that procedure.

In order to control for the extending countries' propensity to patent in general, population and GDP per capita stand for proxies of the size and the development level. The commitment to R&D is expressed by the gross expenditures on R&D as ratio of the GDP (GERD). These three variables are expected to have a positive influence on the number of extended patents even if the limited subset of different countries might influence the coefficients of the "population" variable. In a similar way, the main characteristic of the destination countries are reflected by their population and GDP per capita.

Finally, the economic involvement of one country in another is described through the volume of export and the inward FDI.

Table 7 provides descriptive statistics of all the variables involved in the regression analysis.

Table 7 Descriptive statistics of the dependent and independent variables

Variable description	Obs	Mean	Std. Dev.	Min	Max
Dependent variables:					
Extended patents	912	4466.43	10950.21	0	71424.00
Extended patents - IPC: A	912	965.45	2754.72	0	23510.00
Extended patents - IPC: B	912	1116.58	2770.55	0	16231.00
Extended patents - IPC: C	912	1161.58	2905.97	0	22562.00
Extended patents - IPC: D	912	124.12	287.74	0	1836.00
Extended patents - IPC: E	912	107.09	287.42	0	2115.00
Extended patents - IPC: F	912	494.06	1196.82	0	7514.00
Extended patents - IPC: G	912	1382.66	3665.21	0	29274.00
Extended patents - IPC: H	912	1336.49	3379.12	0	27355.00
Independent variables on patent systems:					
Harmonization as absolute difference in PPI	912	1.16	0.92	0.00	4.02
Budapest treaty (origin country)	912	0.68	0.47	0	1
Strasbourg Agreement (origin country)	912	0.68	0.47	0	1
Paris Convention (origin country)	912	0.94	0.24	0	1
Total PCT filings per country of origin	912	7273.36	12930.62	0	47396.00
Budapest treaty (destination country)	912	0.77	0.42	0	1
Strasbourg Agreement (destination country)	912	0.81	0.39	0	1
Paris Convention (destination country)	912	0.96	0.18	0	1
Total PCT filings per destination office	912	8567.41	13244.02	0	47240.00
Budapest treaty (contemporary memb.)	912	0.90	0.30	0	1
Strasbourg Agreement (contemporary memb.)	912	0.52	0.50	0	1
Paris Convention (contemporary memb.)	912	0.55	0.50	0	1
Independent macroeconomic variables:					
Trade: Export	906	22251.54	40332.53	0.00	326617.40
Trade: Import	906	24780.34	43900.57	0.01	338282.40
FDI: Inward	715	3567.37	15825.82	-5873.83	214478.00
FDI: Outward	690	4057.13	17100.16	-32949.00	207532.10
GDP per capita: Origin country	912	12.27	12.89	0.27	41.83
GDP per capita: Destination country	912	14.39	13.26	0.27	41.83
Population: Origin country	912	396.10	413.92	43.30	1312.98
Population: Destination country	912	354.06	387.30	43.30	1312.98
GERD: Origin country	867	4.11	7.71	0.20	37.70
Distance: Neighbouring	912	0.17	0.38	0	1

4.4.1. RESULTS

The regression results are described in Table 8. The observations are lower than the whole set of available flows because of data completeness: in particular, data on R&D expenditures (GERD) and FDI are not traced for all the countries and years examined in this work.

Three similar regressions have been run in order to test the relevance of different variable while controlling for their robustness. The first regression considers as main dependent variable the harmonization level, measured through the difference in PPI, the second and the third refer to international membership dummies, respectively when both the involved countries are part of the treaties and when only the extending or the recipient countries are part of the agreements. The variables about international memberships are treated separately from the harmonization level since the PPI includes the presence in the international agreements among its components.

The analysis of the controlling macroeconomic variables reports a group of expected results even if some others are not as significant as the scientific literature stated. This can be ascribed to the particular limited set of countries involved in the study. The development level of the origin country, proxied by the wealth of country population, and the consumption capacity of the destination market, that is the GDP per capita of respectively the extending and the recipient countries, are significantly positive in all the three regression analyses.

The involvement of one country into another is positively significant for what concerns the trade and in particular the export of goods: the flow of patents and the flow of goods appear to move in the same direction and related to each other. On the contrary, the import of goods and the FDI (in both directions) do not appear correlated to the patent flows studied in this sample of POs.

The GERD, which measures the R&D effort of the origin country, thus not significant is always positive as expected.

The independent variables which describe the harmonization level and the international membership are almost all significant. The difference in PPI between extending and receiving countries reports a negative sign: the more similar the patent systems are when measured through the PPI, the higher the number of patent application extended from the first to the second considered country is. In a similar way, when both the involved POs are member of international treaties such as the Paris Convention, the Strasbourg Agreement and the Budapest Treaty, the expected flow of patent among the two countries is higher. The same analysis on each single agreement signed by the origin or the destination country confirms the importance of joining those treaties to raise the number of patent export and import (even if no significant coefficient was found for being a member in the Budapest treaty to export patents and in the Paris Convention to import patents).

Finally, the number of PCT filing is positively significant only when considering those received at the destination PO and not those originating from the extending one.

Table 8 Regression results: Negative binomial – patent application flows among selected POs.

Regression	**(1)**		**(2)**		**(3)**	
Observations	592		592		592	
Harmonization as absolute difference in PPI	-0.608	***				
Paris Convention (contemporary memb.)			1.463	***		
Budapest treaty (contemporary memb.)			0.165	**		
Strasbourg Agreement (contemporary memb.)			0.534	***		
Paris Convention (origin country)					1.720	***
Budapest treaty (origin country)					-0.124	
Strasbourg Agreement (origin country)					0.594	***
Paris Convention (destination country)					0.200	
Budapest treaty (destination country)					0.645	***
Strasbourg Agreement (destination country)					0.384	***
Total PCT filings per country of origin	-0.001		0.001		0.001	
Total PCT filings per destination office	0.001	***	0.001	***	0.001	***
GDP per capita: Origin country	0.021	***	0.015	***	0.012	**
GDP per capita: Destination country	0.019	***	0.030	***	0.026	***
Population: Origin country	0.001	***	0.001		-0.001	
Population: Destination country	0.001		-0.001		0.001	
Trade: Import	-0.001		-0.001		-0.001	
Trade: Export	0.001		0.001	**	0.001	***
FDI: Inward	0.001		0.001		0.001	
FDI: Outward	-0.001		-0.001		-0.001	
Distance: Neighbouring	0.585	***	-0.063		-0.125	
GERD: Origin country	0.003		0.002		0.003	
Constant	1.269	***	-0.956	***	-2.039	**

The same regressions have been run considering partial subsets of the extended patents from one PO to another. The eight subsets correspond to the eight IPC sections. This analysis has been performed in order to evaluate possible differences in the trends according to the type of patents extended. Table 9 reports the regression analyses based on the IPC sections subsets where the dependent variable is the harmonization level. Only the sign and the significance of the coefficients are shown to improve readability.

Table 9 Regression analyses where the dependent variables are the patent flows broken down by IPC section

Subset of extended patents. IPC Section:	**A**		**B**		**C**		**D**		**E**		**F**		**G**		**H**	
Harmonization as absolute difference in PPI	***	(-)	***	(-)	***	(-)	***	(-)	***	(-)	***	(-)	***	(-)	***	(-)
Total PCT filings per country of origin		(+)		(+)		(+)	*	(-)		(-)		(-)		(+)	**	(+)
Total PCT filings per destination office	***	(+)	**	(+)	***	(+)		(-)		(+)	***	(+)	**	(+)	***	(+)
GDP per capita: Origin country	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)
GDP per capita: Destination country	***	(+)	***	(+)	***	(+)	**	(+)	***	(+)	***	(+)	***	(+)	***	(+)
Population: Origin country	**	(+)	***	(+)		(-)	**	(+)	**	(+)	**	(+)	***	(+)		(+)
Population: Destination country	***	(+)		(-)		(-)		(+)		(+)		(-)	**	(+)	**	(+)
Trade: Import	**	(-)		(-)		(-)		(-)		(-)		(-)	*	(-)	***	(-)
Trade: Export		(+)		(+)		(-)		(+)	**	(+)		(+)	*	(+)	***	(+)
FDI: Inward		(+)		(+)		(+)		(+)		(+)		(-)		(+)		(+)
FDI: Outward		(-)		(+)		(-)		(+)		(-)		(+)		(-)		(+)
Distance: Neighbouring	***	(+)		(+)	***	(+)		(+)		(-)		(+)	**	(+)		(+)
GERD: Origin country	*	(+)		(+)	**	(+)	**	(+)		(+)		(+)		(+)		(-)
Constant	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)	***	(+)
Observations	590		573		590		550		546		577		577		588	

The harmonization level is robust for all the IPC sections, confirming the previous results. The number of PCT filings, both from the origin country and to the destination PO, reports substantially the same results described above.

All the controlling variables show similar results to the main regression analysis in some cases highlighting the positive sign and the significance which was not found in the previous regressions.

4.5. CONCLUSION

This study aims to provide some insights to the reasons of the recent increase in foreign patent applications. The investigated variables can be grouped in two classes: patent system indexes and data in terms of proximity between each pair of countries and macroeconomic values related to the extending and recipient countries and the involvement in each other.

Controlling for the macroeconomic characteristics, the proximity of the patent systems, proxied by the absolute difference of the Ginarte and Park PPI, appears to be significant: where the two POs are closer, there the flow of extended patents is greater. The same analysis performed with a focus on the memberships in international agreements reports similar results: being part of an international agreement, such as the Paris Convention, the Budapest Treaty and the Strasbourg Agreement favour the export and import of patents respectively from and to the member country, with only two exceptions: accessing the Budapest Treaty and the Paris Convention does not seem to have a significant effect respectively in exporting and importing foreign patents. The effect is always positive and significant when both the extending and the recipient countries have joined an international treaty.

The increase in the number of PCT filings in the recipient country positively affects the total number of imported foreign filings. On the contrary, an increase in the number of PCT applications originating from one country does not seem to affect the flow of exported patents. Among the selected POs the use of PCT procedure seems to have a positive influence on the number of imported patents rather than on the exported.

The proximity of the patent system to that of the extending country seems to facilitate the patent extension procedure: the harmonization of national patent systems in this sense plays a facilitating role in the flow of patents from one country to another.

The involvement into each other country, accounted by FDI and trade volumes, does not report a clear correlation with the number of international filings but it is worth reminding that the FDI data are not available for all the countries in all the years considered.

Future research may clarify the role of the variables considered by extending the number of recipient offices and increasing the number of observations by gaining more data on variables such as R&D expenditures and FDI.

5. PATENT QUALITY: AN EMPIRICAL ANALYSIS OF PATENT OPPOSITIONS AT THE EPO

5.1. INTRODUCTION ON PATENT QUALITY

The on-going debate on the effectiveness of patent systems focuses on different aspects ranging from quantitative to qualitative perspectives. The reduction of the patent backlog and an improvement of the quality of the granted patents are faced through different initiatives arisen all around the world. The relevance of the quality of the issued patents is strictly entangled to the problem of the increasing backlog in most of the patent offices and to the increased number of activities started with the aim of harmonising the patent procedures all over the world, such as the IP5 project, the various Patent Prosecution Highways or the still pending debate on the unique "EU Patent" which should be valid throughout the EU 27 member states.

Even if the levels of backlog and quality are not the same in the several granting authorities of the corresponding countries, the effort to harmonise the different patent systems stresses the relevance of a high quality response to the increased amount of patent filings.

In this Chapter we focus on the qualitative aspects of the patent system: we first try to shed light on the definition of quality itself as it is perceived by two relevant groups of users: companies and public research organisations (PROs) and then we carry out an empirical analysis of patent oppositions at the EPO, since such a procedure is often considered an effective corrective tool which improves the European patent system quality.

Although the quality issue seems to be a hot topic more for the USPTO, the need to improve the quality of the patent system in order to spur innovation and competitiveness is considered extremely relevant also in Europe, as it has been clearly stated by the European Commission and by the European Council in various recent documents (European Commission 2004 and 2007; Council of the European

Union, 2004; European Parliament and Council 2004). Under this perspective, the characteristics and performances of the patent system are strictly connected to the central role of the issuing authority, the PO, and thus to its effort in improving the patenting process in each stage, prior art search, examination, grant, maintenance and any other procedure enacted to improve the quality of the service.

The debate on patent quality is approached from different perspective. The identification of a definition of quality for a patent may lead to several results according to the diverse objective functions that characterise the subjects involved in the patent system. The concept of patent quality can be assessed along different major dimensions. Under a systemic point of view, Burke and Reitzig (2007) defined patent quality in terms of the techno-economic quality created by the patent's underlying invention and the legal quality created by the patent's reliability as an enforceable property right.

The quality of the patented invention is strictly related to its value. The value of the invention and of the corresponding patent is frequently analysed in literature through different aspects of the patent document such as the number of forward citations or the number of countries where the patent has been extended. The corresponding studies investigate the correlations between the commercial value of the protected invention and the characteristics of the design of the patent document. Results could be read to better understand trends and specificities in patent filings and to facilitate the applications of more likely valuable innovations.

The need of an improvement in the quality of the patent system may refer to the rationale and the social value in the existence of a patent system which grants monopoly power in exchange of disclosure to foster innovation. In this sense, the quality of the patent system describes the distance from the optimal configuration in the definition of the patentable subject matter, that is what can be protected by means of issued patents. The definition of a high quality patent in this case is that of a patent which satisfies the statutory requirements (Merges 1999) and the most relevant issues are on the boundaries of the patentable subject matter, such as on the existence of patents on software and business methods. When quality is intended as patent's reliability in case of enforcement, Merges (1999) clearly states that high quality patents are simply valid patents, whose legal certainty cannot be challenged. Hence, the most suitable way to evaluate patent quality is to measure how well the patent meets the statutory requirements of the jurisdictions in which it is issued: patentable subject matter, utility, novelty, non-obviousness, appropriate disclosure and enablement.

Under the same perspective, patent quality can also be assessed from the standpoint of certainty as to the validity and scope of the patent claims when opposed (where the system allows it) or challenged at courts. In this approach the role of the granting authorities and its characteristics are particularly relevant: the quality of the patent is measured through the quality of the examination process at the patent office as an efficient implementation of the statutory requisites. Weak patents, due to an inadequate examination process, might damage competition and eventually harm innovation incentives, with detrimental effects for consumers.

A somehow complementary approach to the interpretation of patent quality is the one based on economic considerations. In this case, a desirable, high quality patent should cover only those inventions that would not have been made without the incentive provided by the protection of the intellectual property right. However, many patents that are not commercially valuable are presumably of good quality from the standpoint of the statutory criteria. Therefore, this measure of patent quality is perhaps more a subjective indicator of whether or not something is a desirable invention, rather than a reflection of the quality of the patent itself (Walmsley Graf, 2007).

In this study we first frame patent quality as it is perceived by patent holders trying to examine different dimensions of quality (Section 5.2), by providing statistics from a survey carried out on firms and PROs: we directly asked patent holders to assess their definition of quality and to provide their opinion on the current strengths and weaknesses of the European patent system. Then we move to a more empirical analysis by addressing the concept of patent quality in reference to the EPO patent opposition procedure (Section 5.3).

5.2. EVIDENCE FROM EUROPEAN FIRMS AND PUBLIC RESEARCH ORGANIZATIONS

In the previous section we have described how the definition of quality of a patent is related to which player is involved. Given the design of the patent system and of the patent document, we questioned patent applicants to assess the definition of patent quality according to some proposed dimensions which refer to the statutory requisites, the legal certainty and also to features which are particularly relevant for patent owners: costs and timeliness. The focus on patent holders imply to enlarge the dimensions through which quality can be measured: considering only the dimension of strict compliance with statutory requirements might lead to a simplification of the overall framework and to an underestimation of the potential systemic impacts of low quality patents. Indeed, understanding patent quality requires the acknowledgement of the presence of significant trade-offs within patent systems.

A clear example of such trade-offs attains the costs of performing a virtually perfect patent examination with a null error probability by a PO. Such costs are both monetary, in the form of patent fees, and non-monetary (e.g., longer time required to perform the screening of all prior art). Lemley and Shapiro (2005) discuss this issue in detail, stressing how a relevant stream of economic analyses has emphasised that expending the resources required to increase the certainty of issued patents may not be economically efficient, given the very small percentage of granted patents that end up being commercially important.

In particular, Lemley (2001) took a clear position on the cost-quality trade-offs, suggesting how "high" patent quality might be an inefficient goal. It would be more efficient to allow market forces (mostly in the form of patent litigation proceedings or opposition procedures) to correct mistakes. The benefit would consist of the fact that only actually valuable patents are challenged in courts. However, such mechanisms seem to be reliable only when the related costs of accessing justice are sufficiently low. Furthermore, a large literature has highlighted how the action of invalidating a patent generates significant positive externalities, eventually reducing private incentives to litigation (Lemley and Shapiro 2005; Gilbert, 2004; Farrell and Merges, 2004). Moreover, other scholars have argued that the benefits of avoiding highly uncertain patents are sufficiently great that society should devote to it additional resources (Gallini, 2002)

The concept of patent quality, as perceived by the users of the system, needs therefore to be expanded to include additional factors related to costs of patenting and timeliness. From this perspective, for a patent-granting authority the concept of patent quality can be represented as an optimisation process that balances three different dimensions: i) the performance of the product provided to customers; ii) the costs incurred; and iii) the timeliness of the service provided. Only the first of such dimensions is the quality according to the statutory definitions.

However, it has to be recognised that PO "customers" are not a homogenous entity because they include subjects seeking patent protection, the ones who do not seek patent protection but freedom to operate, as well as the ones who just use patent information as a source of technical knowledge. Moreover, among patent applicants, significantly different goals and related requirements can co-exist: some companies can adopt aggressive patenting strategies, whereas others use patents mostly as a defensive tool; some applicants might be seriously concerned with the monetary costs of the patent examination, whereas others might accept higher costs for a sounder and more in-depth analysis of prior art. Hence, the combination of performance, cost and timeliness is different and conflicting, depending on the usage of the patent system. In assessing the notion of quality from the perspective of a granting authority, it is worth recalling the existence of additional factors, both external and internal. Concerning external factors, statutory requirements represent in principle a rigid constraint. An additional external factor attains the level of certainty of the patentable subject matter. On this issue, Hall (2007) stresses that most of the changes in patent policy on patentable subject matter in the United States resulted from court decisions, which do not always necessarily take into consideration the broader implications on the quality of the patent system at large.

Concerning internal factors, it should be considered that the internal system of incentives of granting authorities might produce non-desirable effects on patent quality. When the patent fee system is characterised by cross-subsidisation because examination processes are partly financed by renewal fees, incentives might emerge to grant too many patents. Cowan et al. (2006) stress that for a patent-granting authority, it is more difficult and time-consuming to deny a patent than to grant it. The grant of a patent does not have to be justified vis-à-vis the applicant, whereas a refusal will have to be based on sound reasons.

This section presents the results of two surveys that have collected evidence on the current quality of the European patent system from both enterprises and PROs across European countries. The questionnaire has been designed by taking into consideration the issues reviewed in literature. In particular, the survey aims at identifying the most critical aspects of the current system as well as the expectations of European firms and PROs from prospective reforms.

The survey addresses the issue of patent quality from the point of view of the individual patent (focusing on the quality and duration of the examination and related procedures) and from a systemic perspective, extending the analysis to the evaluation of additional factors that might hamper the perceived quality and effectiveness of the patent system. Such factors include the costs for obtaining and maintaining patents, the capability to access justice to properly enforce patents and the implicit costs related to the fragmented structure of the European patent system.

Given the heterogeneous nature of the concept of quality in the area of patents, respondents are provided the possibility to express their view on the definition of patent quality. This should provide useful guidance in the assessment of the expected impact of policy reforms. In this respect, the survey is expected to also shed light on the variegated relevance of patent quality across different typologies of users. The data collected allows for the observation of the specific implications of patent quality for innovators, classified according to their technological sector, size (SMEs and large corporations) and scope of the market (national, European and global).

The decision to involve universities and public research centres in the analysis comes from the increasing relevance of technology transfer policies as a tool to foster innovation in Europe. Aside from this, in recent years some studies have highlighted the non-trivial contributions of academic patents in some sectors (Lissoni et al 2008). Public research organisations are likely to face specific constraints and might have a peculiar view of the quality of the current European patent system.

We received answers from 221 companies and 98 PROs[66] representing almost all of the industries. The most important and clear results that emerged from the two surveys are summarised in the next paragraphs which, for the sake of clarity, are organised along the main themes addressed in the questionnaire.

Understanding the notion of patent quality

Among three different options to assess the quality of a patent, "optimal balance between scope and legal certainty", "clear disclosure of innovative contents" and "high inventive step", companies largely indicated "optimal balance" and "clear disclosure" as the most significant measures of quality, regardless of firm size; universities and PROs, in contrast, assigned to "inventive step" the highest importance. We argue that companies are well aware that quality builds on a balancing process in which strict legal compliance is just one component.

Concerning the options to assess the quality of a patent system, "strong compliance with legal requirements for patentability", "cost effectiveness (affordable procedural fees)" and "timeliness (a patent is granted within 3 years from the filing)", large companies definitely consider legal certainty the most important requisite. SMEs, on the contrary, express a preference for cost effectiveness and only secondarily legal security, whereas they are almost unconcerned with timing. This result suggests that the effectiveness of the patent system in terms of procedural features depends to a higher extent on the pecuniary costs incurred for obtaining patents, rather than the speed.

When asked to rank different items to indicate their relative importance for the quality of the patent system, "High legal certainty concerning patentable subject matter" ranked first, both for large companies and SMEs. SMEs, universities and PROs considered "Minimised fees for obtaining and handling patents" very important. The results suggest that companies consider a clear and secure definition of the boundaries of patentable subject matter to be extremely relevant for patent quality. This consideration might imply that companies perceive uncertainty on patentable subject matter as a potential driver of low quality patents.

[66] Some caveats are highlighted in Appendix 8.3.1.

The difficulties and costs for monitoring the market and enforcing granted patents against imitators are considered the most relevant reasons for adopting other measures to protect innovations. Interestingly, such motives have a higher impact than possible uncertainty on the validity on granted patents, stressing once more how effectiveness and quality of the patent system as a whole is influenced by additional factors beyond the goodness of the examination process. This is especially true for SMEs. The cost of patenting, in terms of fees, enforcement or patent attorneys, is indicated by a large share of respondents. Motives related to costs are much more relevant for SMEs than for large companies.

The perceived quality of different patent systems

Companies assigned the European patent system the highest overall rating (2.90 on a scale from 1 to 4); the JPO received a positive evaluation too (2.74), whereas the rating averages of KIPO, USPTO and SIPO are below the middle value of 2.5. In particular, data reflect an appreciation by patent users of the relatively small backlog of the EPO, as compared to the other POs.

The search and examination process

The examination process is positively considered by a large share of respondents (approximately 80%) in each of its stages, nevertheless there is room for improvement: the communication with and the provision of guidance from the examiner in drafting and adjusting the contents of the patent are areas that do not completely satisfy the evaluation of the users; moreover, only half of the respondents declare that the examination process has been similar and standardised across the different EPO applications, confirming the presence of significant heterogeneity at the level of the examiner and of management of patent documents inside the EPO. Such evidence stresses the importance of implementing appropriate tools for controlling the patent process and examination activities.

Relevance of patent costs

More than half of the sample of companies considers the current structure of fees complex and fragmented and for 78% of SMEs the amount of fees until the grant of patents represents a significant financial burden. Results clearly indicate the non-negligible impact of marginal additional validation costs. Maintenance fees for validated patents are a high obstacle for the company in 41% of the cases when considering less than four designated countries. Such percentage increases dramatically to 76% (93% in the case of SMEs) when considering more than four countries.

Translation costs represent a heavy financial burden for 77% of respondents, and there is a unanimous agreement that the EU Patent should provide a significant reduction beyond the current benefits generated by the London Agreement.

Enforcement of granted patents

96% of respondents agree on the fact that the current fragmentation across different jurisdictions generates excessively high legal costs and excessive uncertainty on the enforceability of patents, eventually harming patenting incentives. The expected costs of accessing patent courts are so high that they discourage patent owners from filing suits for 87% of surveyed companies. The risk of diverging outcomes from infringement proceedings at different European Courts has a strong negative impact on the incentives for patenting for more than 80% of respondents.

Proposals for the improvement of the quality of the European patent system

Nearly all of the surveyed companies agree on the fact that the EU Patent should provide a very high level of legal certainty. Moreover, large relevance is assigned to the cost factor, in terms of a strong reduction of both translation costs and administrative costs related to the validation procedure. Among the proposed initiatives, the improvement of the interaction with patent examiners received a nearly unanimous agreement: this might speed up the examination process and improve the clarity of granted patents.

Universities and PROs

The component of patent quality which received the highest rating is the "high inventive step" option. Universities and PROs seem to give a particular relevance to the level of innovativeness of patents, even when all the quality components report high rating averages.

The perceived impact of patent costs confirms that they actually represent a non-negligible burden for universities and PROs. In particular, 90% of respondents consider the amount of maintenance fees for patents validated in more than four countries a significant obstacle. In addition, translation costs represent a factor potentially harming the patent system for more than 80% of respondents.

The data reveal a generally lower importance of patent infringement for the respondent organisations compared to companies. However, there is strong agreement on the fact that the current average litigation costs can indeed discourage patent owners from filing suits and that the fragmentation of the European patent system across different jurisdictions contributes to generate very high legal costs.

Concerning the expectations from the introduction of the EU Patent, universities and PROs generally express the same level of consensus indicated by companies on legal certainty and costs. However, a relatively higher relevance is attributed to the item that states "the EU Patent should reduce the administrative burden by reducing the current procedural complexity". This probably reflects the fact that surveyed organizations have to bear non-negligible costs to deal with patent management activities.

5.3. EMPIRICAL ANALYSIS OF PATENT OPPOSITIONS

In this section, we conduct an empirical analysis based on European patent data that is expected to provide complementary quantitative information to the evidence collected through the surveys. In particular, we analyse a large sample of patent opposition cases that took place from 2000 to 2008. A patent opposition is a peculiar procedure of the EPO that allows third parties to question the actual validity of a granted patent during the first nine months after the grant date. Since it is a costly process[67], oppositions are not filed randomly, but they usually involve patents presenting certain characteristics (in terms of strategic value and technological relevance).

[67] See Appendix 8.3.2 for further details on the average costs of patent opposition procedure.

The observation of the incidence of EPO opposed patents and of the outcomes of the opposition proceedings can provide additional evidence on the quality of the patent examination process. However, we are aware of the fact that only a small fraction of patents are subject to opposition. Hence results cannot be fully extended to draw results on the quality for the "average" patent.

5.3.1. THE OPPOSITION PROCESS

An opposition notice has to be filed within nine months of the grant of the patent by the EPO (art. 99, EPC). The patent may be opposed by third parties (for example the applicant's competitors) if they believe that it should not have been granted. Once the opposition has been filed, settlement options between the opponent and the patent holder are restricted. The conclusion of the opposition proceedings can lead to the following outcomes: the opposition is rejected and consequently the patent is upheld without amendments, the patent is revoked, or the patent is amended. According to Harhoff et al. (2007), to sort out an opposition case takes on average 1.9 years. The opposition procedure takes approximately 2.2 years if the patent is revoked and approximately four years if the patent is amended. Undoubtedly, the longer the process to sort out an opposition case, the worse the effects on patent holders and competing firms. Whereas patent holders will have to delay the exploitation not only of the granted patent but also possibly of other patents if the extent of legal protection against imitators is unclear, competitors will also be refrained from investing further in the invention under assessment.

For a more extensive technical description of the opposition procedure, estimates of the costs and characteristics drawn from the existing literature on the topic, please refer to the correspondent Appendix 8.3.

5.4. PREVIOUS STUDIES OF PATENT OPPOSITIONS AND RESEARCH SETTING

The criticism recently raised by different scholars in the United States against the poor quality of USPTO patents is actually based on the analysis of the growing phenomenon of patent disputes (Bessen and Meurer, 2008). Scholars are questioning whether or not the direct and indirect costs associated with enforcing patent rights in legal cases due to poor ex-ante quality of granted patents are imposing an implicit tax on innovation in vital segments of the economy (Jaffe & Lerner, 2004; Hall and Ziedonis, 2001). Many claim that the United States can benefit substantially from adopting an administrative post-grant patent review, provided that the post-grant mechanism is not too costly (Graham and Harhoff, 2006). In fact, the adoption in the US of a centralised post-grant opposition system, similar to the one present in Europe, may lower litigation costs and favour speediness in the resolution of patent disputes.

Whereas the economic literature has largely focused on patent litigation issues in the US, only a few studies have examined EPO patent opposition cases (Harhoff et al., 2003; Harhoff and Reitzig, 2004; Calderini and Scellato, 2004; Graham and Harhoff, 2006; Hall et al. 2003; Burke and Reitzig, 2007; Hall et al., 2009). Because legal mechanisms and institutions to challenge patent validity differ significantly between the US and Europe, it is clear that results based on the US context cannot be easily transferred to the European one, and that greater evidence on European procedures is needed.

Harhoff et al. (2007) document that a total of 7.2% of all granted patents were opposed between 1980 and 2005, and roughly one third of these cases were then continued by an appeal. Existing studies have shown that, on average, approximately 30% of opposed patents are eventually amended or revoked after an opposition (Harhoff and Reitzig, 2004; Calderini and Scellato, 2004; Harhoff et al., 2007).

These studies generally find that particularly valuable patents are more likely to be opposed, that patents in fields with technical and market uncertainty or patents with immediate market impact are attacked more frequently and that large incumbents are more likely to attack smaller firms (Harhoff et al., 2003; Harhoff and Reitzig, 2004; Calderini and Scellato, 2004).

Although extant studies on oppositions are so far still limited, they can be grouped into two main strands of literature. The first one examines the correlation between measures of patent value/quality and the opposition event and the strategic implications underlying the decision to file an opposition. Typically, firms challenge more valuable patents. Harhoff et al. (2003) show that patents that survived opposition are on average 10 times more valuable than comparable patents that were not attacked. In a subsequent paper on patent oppositions in the area of biotechnology and pharmaceuticals, Harhoff and Reitzig (2004) apply citation and classification analysis on a large sample of over 13,000 European patents granted between 1979 and 1996, of which 8.6% had been subject to opposition. The authors find that high quality patents are more likely to be opposed and that the probability of opposition is positively correlated to the number of designated states, a proxy for the economic relevance of the patent.

These results are confirmed by Hall et al. (2009), who analyse how the main characteristics of financial patents impact the probability of receiving an opposition. The analysis shows that patent-level characteristics, including family size, forward citations and XY-type backward citations have a significant predictive power. Hence, more valuable financial patents are more likely to be opposed than relatively low-value ones. Calderini and Scellato (2004) provide evidence on patent oppositions at the EPO in the telecommunications sector. Their analysis suggests that larger firms are acting collusively. In fact, major patentees in the telecommunications industry appear as opponents in 48% of the whole population of examined legal cases, but only 14% of the oppositions jointly involve two of them. This evidence points to a possible strategic conduct of large firms, which tend to settle patent disputes among each other, while attacking smaller companies. Harhoff and Hall (2002) also find that in the Cosmetics sector, opposition takes place repeatedly amongst larger players.

A second strand of literature examines the quality of patent office services, in light of the current debate on decreasing patent quality. It is a widespread concern that patent offices are not able to correctly assess patent validity at various stages of a patent's life, especially in emerging technological areas, such as software, biotechnology or nanotechnology. Therefore, frontier technologies or emerging technological areas are more subject to opposition. Harhoff and Hall (2002) document that the probability that a patent will be subject to opposition is proportional to the degree of informational uncertainty concerning the technology covered by the patent. They show that the opposition rate for patent grants in the field of Cosmetics is twice the average rate of other fields. Graham et al. (2002) focus on inter-institutional consistency by comparing the behaviour of European and US patent offices in their opposition and re-examination procedures, respectively, on a selection of patents with identical priorities. It emerges that European and US rule differently in similar cases. Burke and Reitzig (2007) study the concordance of the EPO's granting and opposition decisions for biotech patents granted in the 1980s to investigate which level of assessment quality patent offices can provide. They show, based on bibliographic indicators, that the EPO's decision-making on a patent's technological quality during granting and opposition phases is inconsistent, and that EPO seems to assess patent-quality related information differently in the grant and opposition stages.

5.5. METHODOLOGY AND RESULTS

5.5.1. DATA SOURCES

Data on patent oppositions and patent characteristics have been drawn from Thomson Innovation, a dataset provided by Thomson Reuters. Thomson Innovation provides worldwide patent coverage and a broad collection of scientific literature, as well as information on patent oppositions. For the sub-sample of opposition cases that we want to investigate in detail, we will also search ESPACE LEGAL, the dataset provided by EPO that collects the legal texts of patent opposition disputes.

The data presented in this study were extracted in January 2010 and were restricted to patents issued by the EPO reporting a publication date between 2000 and 2008. Therefore, oppositions were downloaded based on the publication date of the granted patent to which they refer to and not on the filing date of the opposition itself[68].

[68] EPO patents are typically re-published at different stages of the patenting procedure. Hence, there can be multiple publications associated with a given patent. Publications of the same patent are differentiated by a code, which consists of a letter (typically A or B) followed by a number. B codes (e.g., B1, B2) are used for issued patents. In this study, we refer only to B1 codes.

Nearly a half million patents were granted in the time span considered[69]. For each granted patent, we collected information on: priority (date and country), application date, publication date, number of inventors, assignee (names and number), IPC classes, patent citations (number of forward and backward citations), number of claims, oppositions (name of the opponent, opposition filing date), and INPADOC legal status (to infer information on the outcome of oppositions).

5.5.2. OPPOSITION TRENDS IN THE YEARS 2000-2008

The mechanism of opposing patents seems to be a frequently used one in Europe. Harhoff et al. (2007) analyse the frequency of oppositions since 1980. They report that a total of 9.26% of all granted patents were opposed between 1980 and 2000. We complemented their study by analysing the years not considered by the authors, namely, from 2000 to 2008.

In the Table 10, we show the frequency of oppositions for all patent grants occurring between 2000 and 2008 and, in the subsequent Figure 11, we provide a chart of the trend since 1980, by including the statistics found by Harhoff et al. (2007). The number of granted patents has significantly increased over the years, reaching a peak in 2006. The number of oppositions has followed the trend registered in the patent-granting process. The number of oppositions reaches a peak in 2006, which is in line with the increase in the number of granted patents in that year. However, the opposition rate slightly decreases over the years. According to our data, on average, a total of 5.28% of all granted patents were opposed between 2000 and 2008.

Different explanations have been given to the decreasing trend in the percentage of newly patented innovations subject to opposition[70]. A first straightforward explanation is that the examination process at the EPO has improved, leading to a reduction in the number of granted patents whose actual validity is challenged by

[69] We also searched data for year 2009, but these data are partial when considering oppositions because opposition notices can be filed within the nine months following the grant of the patent by the EPO. Therefore, the majority of opposition proceedings referring to patents granted in 2009 have appeared after january 2010. Moreover, because the dataset updated retrospectively, it might also be the case that important patent information is missing for the year 2009. For these reasons, in the empirical analysis we will focus on the period 2000-2008.

[70] See Harhoff (2006).

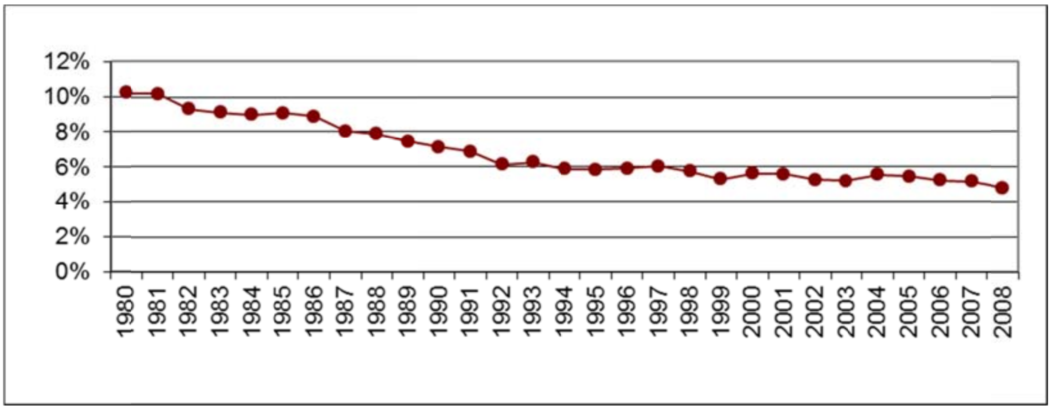
third parties. In this sense, the decreasing trend might be considered a signal of relative inter-temporal improvements in patent quality.

However, the observed trend might also be influenced by additional factors. First, the rate of opposition might have decreased because a greater number of marginal patents, which are not damaging for competitors and have a lower economic value, have been granted. Second, it might be the case that an increasing "free riding" phenomenon among potential plaintiffs has contributed to the decrease in opposition rates. If a "doubtful" patent has a negative impact on multiple companies, this can lead individual firms to refrain from opposing, waiting for other firms to attack first without bearing the costs of opposition, while reaping the social benefits. Third, companies might have incentives to settle patent disputes outside of patent offices.

Table 10 EPO patent grants and oppositions (years 2000-2008)

Publication year	**Opposition rate**
2000	5.61%
2001	5.59%
2002	5.24%
2003	5.19%
2004	5.56%
2005	5.44%
2006	5.23%
2007	5.17%
2008	4.79%
Total	5.28%

Figure 11 Opposition frequency (years 1980-2008)



Note: Opposition frequency is drawn from Harhoff et al. (2007) until 1999; since 2000 it has been computed on our data as the number of patents opposed divided by the number of all patents granted in a given year.

5.5.3. SECTORAL DIFFERENCES IN OPPOSITION TRENDS

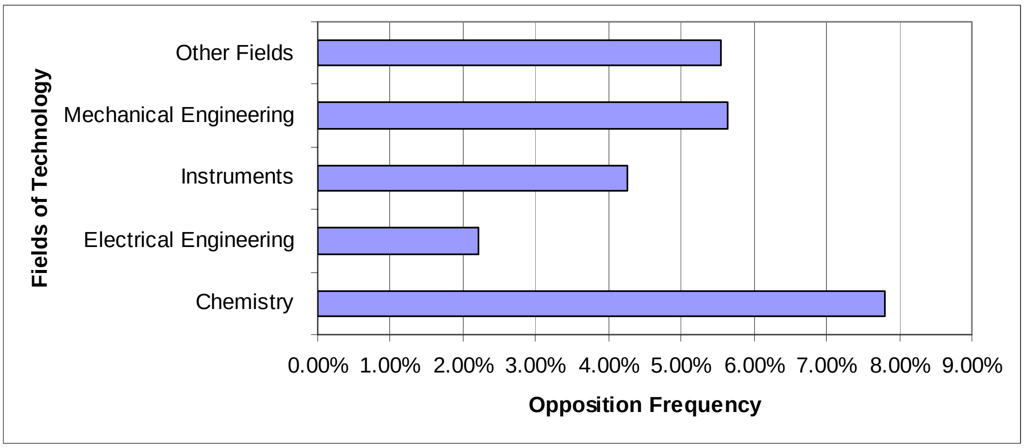
To single out differences in patent opposition trends across different industrial sectors, we examined the share of opposed patents across different technology fields and industrial sectors within the period considered. To identify industrial sectors, we mapped sample patents according to the main IPC class (International Patent Classification). During the EPO examination process, patents are assigned up to nine-digit IPC codes. Patents can belong to different technological fields, and thus they can be assigned several IPC codes. We used the IPC Technology Concordance Table, released by the WIPO (WIPO, World Patent Report: a statistical overview, 2008), which classifies IPC classes into 35 technology areas that can be further aggregated into six macro areas (Electrical Engineering, Instruments, Chemistry, Mechanical Engineering, and Other Fields). According to this classification, each patent is associated with a field of technology and a macro-sector. The analysis is cross-industry, covering the macro fields and most of the sub-fields reported by the IPC Technology Concordance Table.

If we aggregate technology fields into macro-sectors[71], the highest opposition frequency is registered for the macro-sector Chemistry (7.80%). This is not surprising because it gathers as sub-fields food chemistry, basic materials chemistry,

[71] Appendix 8.3.3 shows non-aggregated data for each industry as they were identified via the IPC concordance table.

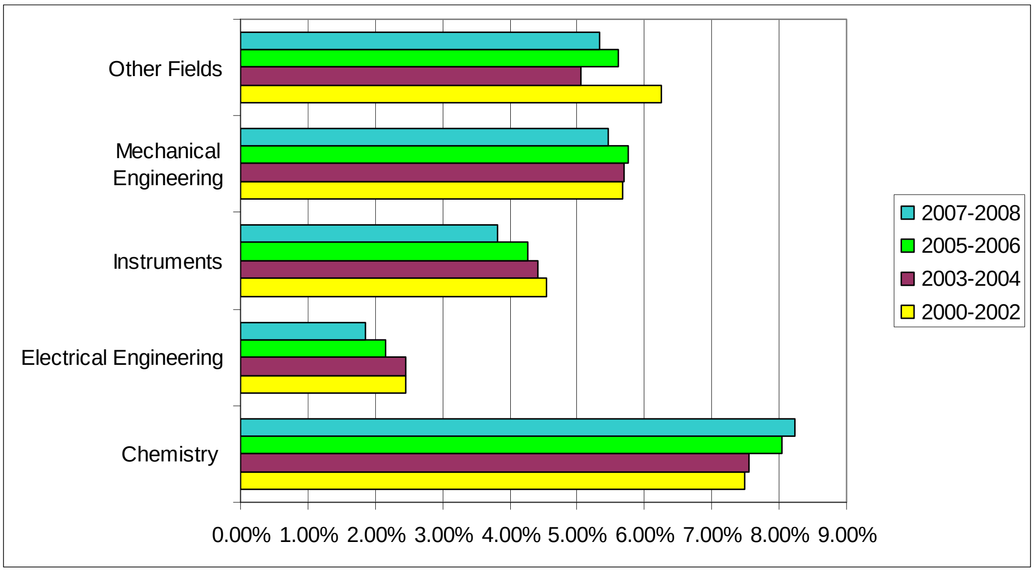
macromolecular chemistry and pharmaceuticals, which are among the technology classes showing the highest incidence of opposition in the years considered. Mechanical engineering ranks second (5.65%). The residual category "Other Fields" shows a relatively high opposition rate, which might be due to incidence of the categories "Other Consumer goods" and "Civil engineering", reporting, respectively, 6.64% and 5.14% of opposition frequency. The lowest incidence of oppositions filed is recorded in the Electrical Engineering sector.

Figure 12 Opposition frequency across macro-sectors (years 2000-2008)



It is interesting to investigate whether or not intra-sectoral variations in opposition frequency can be envisaged across the years analysed (Figure 13). While intra-sectoral opposition rates keep rather constant in the considered years, we observe significant growth in the number of granted patents in the electrical engineering area, which is characterised by low opposition rates. This, in turn, has a "positive" impact on aggregated opposition rates (without being related to any change in the quality of the examination).

Figure 13 Opposition frequency across macro-sectors and periods



5.5.4. CHARACTERISTICS OF OPPOSED PATENTS

It is generally argued that opposed patents are more valuable than unopposed ones (Harhoff et al., 2003). To test this hypothesis, we provide descriptive statistics comparing the sample of opposed and unopposed patents and an econometrical multivariate analysis. The latter is described in the next section while the former is reported in detail in Appendix 8.3.4 and only the main findings are summed up in the following paragraphs.

Descriptive statistics suggest that patents subject to an opposition process are more likely to receive citations from other patents. This evidence is actually in line with previous studies finding that opposed patents are more valuable (Harhoff et al., 2003; Harhoff and Reitzig, 2004; Hall et al., 2009). A similar but weaker relationship between the likelihood for a patent to be opposed and the number of backward citations might be due to two reasons: first, the higher the number of backward citations included by the examiner, the higher the likelihood that the innovative contents of the patent under examination rely on previous innovations and hence, the actual inventive step is more questionable; second, more backward citations to the previous patent literature increase the probability that the owners of cited patents become aware of the newly granted patent and decide to file an opposition.

The priority country analysis shows a certain heterogeneity in the likelihood of receive an opposition: European patents are more subject to be opposed while the data clearly highlight a below average incidence of oppositions in case of patents with a JPO priority. The incidence of opposition frequency does not seem to face variations along the years in the different countries where the first priority was filed.

Finally, when examining the duration of the granting process, unopposed patents show on average a longer duration compared to opposed ones. However, differences in absolute terms seem to be rather small and there is evidence of inter-industry heterogeneity. The average time lag between the date of the first application and the granting date is 19 days longer for unopposed patents. Such results suggest that the opposition event cannot be attributed to a too fast examination by the examiner and it does not seem that a strategy aimed at stretching the duration of the examination is pursued by patent holders aware of having presented patent applications of dubious validity and hence, potentially subject to oppositions.

5.5.5. ANALYSIS OF OPPOSITION OUTCOMES

An opposition may result in different outcomes: it may be rejected or the opposed patent may be revoked or amended (narrowed). In other cases, the opposition proceeding is closed either because the patent-holder let the patent lapse by not paying the renewal fees or by a withdrawal of the opposition by the opponent.

Detailed statistics are presented in Appendix 8.3.5. It turns out that 20% of opposed patents have been amended, whereas 25% have been revoked. In 14% of the cases, oppositions have been rejected. The residual category accounts for 35% of the cases[72]. In the following table we report a modified version of the previous table in which incidence of different cases are computed conditional on a patent showing an outcome. This representation discounts the presence of the residual category consisting of still pending cases. The data suggest a relative stability along time of the typologies of outcome. There is a tendency toward the increase of cases ending with termination requested by the opponent and a reduction of the incidence of cases ending with a patent amendment. Data for more recent years might be affected by

[72] The share of residual pending cases increases through time since the collected data represent a snapshot of the current situation at the EPO.

the fact that those cases ending with a specific outcome (e.g. amendment) imply on average a higher (o lower) duration of the proceedings. Also taking into consideration such caveat, the data do not seem to suggest a significant increase in the incidence of cases of revocation of patents previously granted by the EPO.

Table 11 Outcome of the oppositions over time (2000-2006), by year of granting of the opposed patents, without taking into consideration pending cases.

Outcome	2000 - 2002	2003 - 2004	2005 - 2006
Amended	34.92	29.26	24.13
Rejected	22.24	20.89	20.56
Revoked	36.71	39.13	38.79
Terminated	8.55	10.74	16.13

Table 12 reports the distribution of the outcomes by priority area. It distinguishes between patents with a European first priority and patents with a non-European first priority. Nearly 20% of patents with a non-EU priority are amended, and this percentage is virtually equivalent to the one (19.07%) for patents with a European priority. 26% of patents with a non-EU priority are revoked, whereas this percentage is approximately 24% for patents with a European priority.

Table 12 Outcomes of the opposition process by priority (European versus non-European priority) over time.

	2000-2006		2000-2002		2003-2004		2005-2006	
Outcome (%)	EU priority	NON EU priority	EU priority	NON EU priority	EU priority	NON EU priority	EU priority	NON EU priority
Amended	19.07%	19.88%	28.41%	29.98%	19.74%	20.57%	9.10%	9.75%
rejected	15.19%	12.73%	20.86%	18.87%	15.25%	13.38%	9.50%	6.37%
revoked	23.83%	26.15%	31.78%	34.24%	26.05%	27.93%	13.63%	16.80%
terminated	7.97%	6.12%	8.89%	6.20%	8.30%	6.38%	6.71%	5.82%
residual	33.93%	35.10%	10.06%	10.71%	30.65%	31.74%	61.06%	61.26%

A closer look at the distribution of opposition outcomes across different priority countries indicates that amended patents are the most common outcome in all of the reported countries. However, this situation is strongest in the case of patents with a first priority in Japan, which shows the highest incidence of amended patents (22.65%). The USA and Great Britain show an average percentage of revoked patents of 28%.

Table 13 Outcome of the opposition process by priority country (2000-2006)

	amended	**rejected**	**revoked**	**terminated**	**residual**
USA	19.51%	11.15%	28.56%	6.14%	34.64%
Germany	19.95%	15.77%	22.41%	8.92%	32.95%
Japan	22.65%	15.02%	21.90%	4.47%	35.95%
EPO	17.26%	14.22%	23.76%	6.67%	38.09%
France	19.79%	14.86%	24.72%	5.74%	34.89%
Great Britain	17.65%	10.68%	29.74%	5.56%	36.36%
Italy	17.08%	17.85%	25.72%	7.29%	32.05%

The distribution of the outcomes of opposition processes by macro-sectors is reported inTable 14. The majority of revocations occur in Chemistry. Overall, the data on the outcomes of the opposition procedures seem to suggest that there has not been a significant increase in the incidence of cases ending with a revocation or amendment. The observed composition of amended and revoked patents can be due to differentials in the duration of the proceedings for cases eventually leading to such different outcomes. Even if for recent years little can be said due to the large number of pending cases, we do not find any robust evidence in favour of an average deterioration of the quality of granted patents.

Table 14 Outcome of the opposition process by macro-sector

	amended	**Rejected**	**Revoked**	**terminated**	**residual**
Chemistry	19.36%	12.41%	27.06%	5.87%	35.29%
Electrical Engineering	16.37%	13.98%	24.36%	8.70%	36.60%
Instruments	20.15%	12.45%	25.02%	6.20%	36.18%
Mechanical Engineering	19.80%	15.96%	23.26%	7.49%	33.49%
Other Fields	20.53%	16.48%	22.06%	11.10%	29.83%

5.6. ECONOMETRIC ANALYSIS

The econometric analysis was based on three different sets of models. Firstly, we investigated the determinants of opposition to EPO patent grants between 2000 and 2008. In particular, we examined to what extent the likelihood of observing an opposition is affected by patent characteristics. To do so, we exploited the entire dataset on granted patents that we have created and applied a multivariate probit specification to examine which variables affect the probability to observe (or not) an opposition. For that purpose, we created a binary variable to distinguish between patents that were opposed from those that were not opposed (OPPOSITION).

Then, we performed another set of probit models which investigate the impact of the same variables on the probability that a specific opposition outcome occurs. In particular, we tested the impact of our variables on the probability that the opposition ends up respectively with an amendment or with a revocation. To this aim, we created two binary variables to distinguish between opposed patents that have been amended or not (AMENDMENT) and revoked or not (REVOCATION). For all the considered models we made some robustness checks to see if results hold, for example, by considering different industry effects.

Finally, in order to single out what determines the likelihood of having a pending case, we tested the effect of the characteristics of patents on the probability that the outcome of an opposition is pending. In doing so, we controlled for the patent technology field, its priority country and we included time dummies in all the regressions.

Explanatory variables have been identified among those that we assume can reasonably affect the likelihood of facing an opposition and that can consequently influence its final outcome. To capture phenomena relating to patent value, we use bibliographic indicators, which have been widely validated by previous literature as being good proxies of a patent's economic value (see Reitzig, 2004). The variables we employ in the analysis are reported below and summarised in Table 15.

- *The number of citing patents (forward citations)*: the higher the number of citations a patent receives, the more the patent has contributed to the state of the art, and thus the more valuable it is. Earlier studies have found that forward citations are positively correlated with the monetary value of patents (see Lanjouw and Schankerman, 2001; Haroff et al. 2003). We therefore expect the likelihood of opposition to increase with the number of citations received from subsequent patents.

- *The number of references to patents and to the non-patent literature* relates to references to the state of art relevant for the patentability of the application that are cited by the inventor and the patent examiners.

- *The number of claims* is a potential determinant of oppositions. As the number of claims increases, the complexity of a patent increases as well, and it is more likely that an opposition will be filed (Harhoff and Reitzig, 2004).

- *The number of IPC classifications* relates to the broadness of the patent in terms of technological fields, which can affect the likelihood of opposition. It might be the case that the broader the relevance of the patent, the more potential opponents it may have. In this situation, the number of IPCs may be positively correlated with the likelihood of opposition.

- *The grant lag* (in days) is the lag between the date of the first application and the grant decision. The grant lag can be seen as a further measure of complexity of the exam.

- *The number of inventors and assignees.*

- *PCT application* is a binary variable which indicates that patent applicants are interested in extending patent protection beyond the EPC member states. Because this procedure implies additional costs, it signals the intention of patent holders to commercialise the invention in a higher number of national markets and hence, that the patent has higher market potential. However, a PCT application also allows applicants to postpone decisions regarding the scope of international protection for up to 30 months, and this might reveal an uncertainty about the patent's commercial value.

- *The number of opponents:* A greater number of opponents can be a signal of the fact that the reasons behind the filing of an opposition are particularly relevant.

In the subsequent tables we report the results of the multivariate analyses and provide some conclusions on the most significant and robust outcomes.

Table 15 Variables used in the econometric analysis

Variable	Definition
OPPOSITION	Dummy variable that is equal to 1 if the patent was opposed and 0 otherwise
AMENDMENT	Dummy variable that is equal to 1 if the patent was amended and 0 otherwise
REVOCATION	Dummy variable that is equal to 1 if the patent was revoked and 0 otherwise
PENDING	Dummy variable that is equal to 1 if the patent was pending and 0 otherwise
Forward_citations	Number of citing patents (logarithm)
Backward_citations	Number of references to the patent literature (logarithm)
References_not patent	Number of references to the non-patent literature (logarithm)
Claims	Number of claims (logarithm)
N_IPC	Number of IPC assignments (logarithm)
Grant lag	It refers to the lag (in days) that occurs between the date of the application and the granting date (logarithm).
Non_EU_priority	Dummy variable that is equal to 1 if the patent has a non-European priority (excluding also Japan and US) and 0 otherwise
N_assignees	Number of assignees (logarithm)
N_inventors	Number of inventors (logarithm)
N_opponents	Number of opponents (logarithm)
PCT application	Dummy variable that is equal to 1 if the patent application was designated as a PCT application and 0 otherwise
US_priority	Dummy variable that is equal to 1 if the patent has a US priority and 0 otherwise
Japan_priority	Dummy variable that is equal to 1 if the patent has a Japan priority and 0 otherwise
Sector_dummies	Dummy variables, each of them equal to 1 if the patent belongs to the corresponding technology field and 0 otherwise: Audio-visual technology, Basic communication processes, Basic materials chemistry, Biotechnology, Chemical engineering, Civil engineering, Computer technology, Control, Digital communication, Electrical machinery, apparatus, energy, Engines, pumps, turbines, Environmental technology, Food chemistry, Furniture, games, Handling, IT methods for management, Machine tools, Macromolecular chemistry, polymers, Materials, metallurgy, Measurement, Mechanical elements, Medical technology, Micro-structural and nano-technology, Optics, Organic fine chemistry, Other consumer goods, Other special machines, Pharmaceuticals, Semiconductors, Surface technology, coating, Telecommunications, Textile and paper machines, Thermal processes and apparatus, Transport, Organic fine chemistry.
Macro_sector_dummies	Dummy variables which are equal to 1 if the patent belongs to the following macro sectors and 0 otherwise: Chemistry, Electrical Engineering, Instruments, Mechanical Engineering, Other Fields.
Year_dummies	Dummy variables which are equal to 1 for the years 2000 to 2008 and 0 otherwise.

Table 16 Probit model: probability for a patent of being opposed. Dependent variable: OPPOSITION

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Forward_citations	0.419***	0.417***	0.415***	0.403***	0.402***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Backward_citations	0.272***	0.272***	0.246***	0.266***	0.264***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
References_not patent	0.090***	0.073***	0.067***	0.085***	0.092***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Claims	0.117***	0.108***	0.105***	0.087***	0.088***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
N_IPC		0.068***	0.019***	0.033***	0.034***
		(0.006)	(0.006)	(0.006)	(0.006)
N_inventors		0.068***	0.044***	0.088***	0.088***
		(0.007)	(0.008)	(0.008)	(0.008)
N_assignees		-0.071**	-0.154***	-0.151***	-0.150***
		(0.029)	(0.029)	(0.030)	(0.030)
Japan_priority				-0.395***	-0.402***
				(0.011)	(0.011)
US_priority				-0.163***	-0.163***
				(0.008)	(0.008)
Non_EU_priority				-0.094***	-0.096***
				(0.010)	(0.010)
PCT application					-0.021***
					(0.007)
Sector_dummies			YES	YES	YES
Constant	-2.439***	-2.473***	-2.251***	-3.034***	-3.031***
	(0.016)	(0.026)	(0.084)	(0.195)	(0.195)
Obs.	458,469	458,469	458,469	458,292	458,292
Chi2	4599.304	4854.911	9908.917	11426.449	11434.599
LogLik	-92392.068	-92264.264	-89737.261	-88951.575	-88947.499

** Significant at 10% level; ** significant at 5% level, ***significant at 1% level*

Table 16 refers to the probit model where the dependent variable is the dummy OPPOSITION. The baseline model, in which we include measures of patent value, is presented in the first column. Both backward and forward citations are strongly associated with the probability to face an opposition, pointing to the interpretation that high valuable patents are more likely to be opposed. The number of claims, which captures to some extent the degree of complexity of a patent, is also positively and significantly correlated with the likelihood of oppositions. These figures are constant in all the different model specifications.

In the second model, we include other independent variables such as the number of IPC classifications, the number of inventors and assignees. The number of IPC classifications, which relates to the broadness of the patent in terms of technological fields, is positively correlated with the probability of being opposed, supporting the hypothesis that the broader the relevance of the patent, the higher the probability that the patent is opposed. The probability of facing an opposition is instead inversely correlated with the number of assignees.

In the models 3, 4 and 5 of Table 16 sectoral dummies are included as an additional control: the results appear robust.

In the fourth model, we added some key controls on patent priorities: the presence of a priority from Japan, the U.S. and other non-European countries is inversely related to the probability of receiving an opposition. Hence, a patent showing a European priority is significantly more subject to being attacked than a patent with a non-European priority.

Finally, model 5 includes the dummy variable PCT application, which controls for the correlation between the probability of being opposed and the decision to file the patent under the PCT procedure: making a PCT application negatively affects the probability of facing an opposition, and this evidence might be in favour of the interpretation that a PCT application choice reveals a certain degree of uncertainty about the commercial value of the patent.

In the next paragraphs, we move to the analysis of the outcomes of the opposition procedures. In Table 17 we tested the correlations between the probability of an opposition ending with the patent being revoked and the proposed variables measuring patent value. In this case, the number of received citations is negatively correlated with the probability of being revoked in case of opposition, suggesting that among the set of patents which are disputed those actually rejected receive less citations and can therefore be assumed to be less valuable.

Table 17 Probit regression: probability for a patent of being revoked in case of opposition. Dependent variable: REVOCATION.

Variable	Model 1	Model 2	Model 3
Forward_citations	-0.198***	-0.198***	-0.198***
	(0.033)	(0.033)	(0.033)
Claims	-0.105***	-0.127***	-0.126***
	(0.021)	(0.022)	(0.022)
Grant lag	0.156***	0.130***	0.129***
	(0.039)	(0.041)	(0.041)
Japan_priority		-0.108**	-0.109**
		(0.050)	(0.050)
US_priority		0.128***	0.129***
		(0.036)	(0.037)
Non_EU_priority		0.005	0.005
		(0.045)	(0.045)
N_opponents	0.726***	0.714***	0.714***
	(0.061)	(0.061)	(0.061)
PCT_dummy			-0.004
			(0.029)
Sector_dummies	YES	YES	YES
Constant	-2.339***	-1.699***	-2.099***
	(0.538)	(0.433)	(0.545)
Obs.	9,063	9,063	9,063
Chi2	284.336	306.588	306.604
LogLik	-5534.497	-5523.371	-5523.363
PseudoR2	0.025	0.027	0.027

** Significant at 10% level; ** significant at 5% level, ***significant at 1% level*

Similarly, the number of claims is inversely related to the probability of revocation: a higher complexity and scope (positively correlated to patent value) determine a lower probability of a revocation outcome in case of opposition.

Models 2 and 3 include controls on patent priorities: the presence of a priority from Japan and from the U.S. is respectively negatively and positively related to revocation: Japan-original priority opposed patents are less likely to end with a revocation outcome, while U.S.-original priority opposed patents are more likely. Finally, as expected, a higher number of opponents leads to a higher probability of revocation. The difference in amendment and revocation likelihood of patents with an original priority in the US or Japan might well be caused by structural differences between this two systems (e.g. in terms of average number of claims).

Table 18 reports regression results on the probability of patent amendment in case of opposition. The number of forward citations and the number of claims are positively correlated with the probability of amendment. Models 2 and 3 include controls on patent priorities: only for Japanese priorities regression results show a significant positive coefficient. On the contrary it does not appear any significant effect when the priority is the U.S. or any other non-European country. Finally, the number of opponents is inversely correlated to the probability of patent amendment.

Table 18 Probit regression: probability for a patent of being amended in case of opposition. Dependent variable: AMENDMENT.

Variable	Model 1	Model 2	Model 3
Forward_citations	0.063**	0.064**	0.064**
	(0.032)	(0.032)	(0.032)
Claims	0.162***	0.177***	0.176***
	(0.022)	(0.023)	(0.023)
Grant lag	-0.079**	-0.095**	-0.093**
	(0.040)	(0.042)	(0.042)
Japan_priority		0.220***	0.225***
		(0.049)	(0.050)
US_priority		-0.009	-0.011
		(0.038)	(0.038)
Non_EU_priority		0.000	0.001
		(0.047)	(0.047)
N_opponents	-0.363***	-0.349***	-0.349***
	(0.068)	(0.068)	(0.068)
PCT_dummy			0.015
			(0.030)
Constant	-0.168	0.339	-0.112
	(0.514)	(0.432)	(0.522)
Sector_dummies	YES	YES	YES
Obs.	9,063	9,063	9,063
Chi2	142.871	164.800	165.038
LogLik	-5216.618	-5205.653	-5205.534
PseudoR2	0.014	0.016	0.016

** Significant at 10% level; ** significant at 5% level, ***significant at 1% level*

Table 19 reports regression results on the probability of an opposed patent of being in a pending status. The final decision on opposed patent tends to take longer, leaving the document in pending status in case the patent is particularly complex (many claims) and valuable (many received citations). Moreover, as expected, the presence of many opponents is directly proportional to the probability of not reaching a final outcome from the opposition procedure. In all model specifications we controlled for time effects.

Table 19 Probit regression: probability for an opposition of being in pending status. Dependent variable: PENDING.

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Forward cit.	0.131***	0.133***	0.137***	0.135***	0.137***	0.136***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Claims	0.104***	0.101***	0.103***	0.104***	0.101***	0.120***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Grant lag	0.058**	0.043*	0.055**	0.056**	0.049**	0.051*
	(0.024)	(0.025)	(0.024)	(0.024)	(0.024)	(0.026)
Number of opponents	0.669***	0.679***	0.659***	0.667***	0.658***	0.687***
	(0.045)	(0.046)	(0.045)	(0.045)	(0.045)	(0.046)
Japan_priority						0.147***
						(0.036)
US_priority						-0.074***
						(0.026)
Non_EU_priority						-0.026
						(0.031)
Year dummies	YES	YES	YES	YES	YES	YES
Industry dummies		YES				YES
Macro sector: Chemistry			0.025			
			(0.020)			
Macro sector: Electrical Engineering				0.084**		
				(0.035)		
Macro sector: Mechanical Engineering					-0.045**	
					(0.021)	
Constant	-2.918***	-2.993***	-2.892***	-2.906***	-2.823***	-2.738***
	(0.190)	(0.317)	(0.191)	(0.191)	(0.195)	(0.318)
Obs.	24,185	24,185	24,048	24,048	24,048	24,179
Chi2	12011.730	12148.240	11906.421	11910.587	11909.407	12172.093
LogLik	-10749.510	-10681.255	-10709.884	-10707.801	-10708.390	-10665.009
PseudoR2	0.358	0.363	0.357	0.357	0.357	0.363

** Significant at 10% level; ** significant at 5% level, ***significant at 1% level*

In models 2 to 6 we analysed possible industry specificities by considering industry dummies and three macro-sectors (Chemistry, Electrical and Mechanical Engineering). Patents belonging to Chemistry and Electrical Engineering fields are more likely to be in pending status than those in Mechanical Engineering. The last model includes controls on patent priorities: Japanese priorities are apparently more likely to be in pending status.

Clearly the duration of the proceedings can be affected by numerous and diverse factors including the characteristics and the amount of new evidence proffered by the parties. In this respect, we stress that although we have identified some factors that seem to show a positive - but rather weak - correlation to the duration of the proceedings, what really matters is the average non negligible duration of such proceedings that generates a prolonged period of uncertainty for both the patent owner and the other companies. Any reform and intervention aimed at reducing the average duration of such uncertainty period would have a positive impact on the quality of the system as a whole.

5.7. CONCLUSION

This Chapter have focused on the quality of the patent systems and in particular of the European one. The introductory section has described some of the different approaches which can be assessed in order to identify a definition of patent quality. With the aim of framing such possibilities on the European patent system, we have reported the results of a survey to European patent users, firms and PROs: the collected data allow to highlight the perceived relevance of the various components of patent quality as they are appreciated by the different users. Such heterogeneity can be observed mainly in reference to the institution type (firm or university) and company size (directly proportional to patent portfolio size). Moreover we have presented data describing the users' perceptions on the examination and post-grant processes: thus the former is quite unanimously appreciated, there is room for improvement, especially concerning the communication with the examiners; the enforcement system is considered too fragmented and a hindrance to patent applications. Another negative response came from the answers on patent costs, which are deemed extremely high in particular when designating more than three EPC member countries. Nevertheless, the European system received the highest appreciation among the proposed POs.

One of the distinctive characteristics of the EPO is the opposition process, a post-grant mechanism aiming at improving the quality of the offered service. In the second part of this Chapter, we have carried out a comprehensive analysis of opposition cases involving EPO patents granted between year 2000 and year 2008, by extending previous studies in terms of timespan and computed variables. We are aware of the fact that only a small fraction of patents are subject to opposition and for such reason results cannot be fully extended to draw results on the quality for the "average" patent. However, we claim that the observation of the incidence of EPO opposed patents and of the outcomes of the opposition proceedings can provide some additional evidence at least on the trends in quality of granted patents in recent years.

The data highlight that the opposition rate slightly decreases over observed the years. A first straightforward explanation is that the examination process at the EPO has improved, leading to a reduction in the number of granted patents whose actual validity is questioned by third parties. However, it has to be stressed that the aggregated reduction of opposition rate can be partly due to a significant growth in the number of granted patents in technological areas that are characterised by low opposition rates: we found that intra-sectoral opposition rates keep rather constant in the considered years.

Our set of econometric analysis aims at testing the robustness of summary evidence by jointly controlling for country specific and industry specific effects. Concerning the geographical dimension of the phenomenon, the data clearly highlight that the incidence of oppositions is higher in case of patents with a European priority. Along with such result, it emerges that, among the opposed set of patents, those with a JPO priority are more likely to stay in "pending status" and to end with an amendment, while those with a USPTO priority to end with a revocation. These correlations stress the importance of a harmonised international patent system.

We found robust evidence supporting the fact that opposed patents have on average higher economic and technological relevance, as captured for example by the number of claims and citations and the presence of PCT procedure. The results point to the relevance of strategic alliances since the number of assignees and of opponents are correspondingly inversely and directly related to the likelihood of opposition.

An opposition may result in different outcomes: it may be rejected or the opposed patent may be revoked or amended. In other cases, the opposition proceeding is closed either because the patent-holder let the patent lapse by not paying the renewal fees or by a withdrawal of the opposition by the opponent. Our elaboration suggests a relative stability along time of the typologies of outcome. There is a tendency toward the increase of cases ending with termination requested by the opponent and a reduction of the incidence of cases ending with a patent amendment. Data for more recent years might be affected by the fact that those cases ending with a specific outcome (e.g. amendment) imply on average a higher (o lower) duration of the proceedings. Also taking into consideration such caveat, the data do not seem to suggest a significant increase in the incidence of cases of revocation of patents previously granted by the EPO.

One might argue that the likelihood of observing an opposition can show a significant correlation with the duration of the substantive examination process. Our analyses did not lead us to conclude that there is any actual significant correlation. This can interpreted along different perspectives: i) the opposition event cannot be attributed to a too fast examination by the examiner; ii) it does not seem that a strategy aimed at stretching the duration of the examination is pursued by patent holders aware of having presented patent applications of dubious validity and hence, that are potentially subject to oppositions. Moreover, revoked and "pending-status" patents appear to incur in a longer examination time. We have identified some factors (including number of claims, number of forward citations, number of opponents, the fact of having a Japanese priority) that seem to show a positive - but rather weak - correlation to the duration of the proceedings.

The joint evidence on the effects of patent value and on the elevated incidence of opposition cases filed in recent years and still pending lead us to stress that a key issues is the average non negligible duration of opposition proceedings. This can generate a prolonged period of uncertainty for both the patent owner and the other companies. Any reform and intervention aimed at reducing the average duration of such uncertainty period would have a positive impact on the quality of the system as a whole. Such consideration is particularly relevant in light of the fact that many scholars in the patent field have stressed the importance and effectiveness of post-grant patent review at a cost that can be an order of magnitude lower than the proceedings at national courts.

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7. LIST OF ABBREVIATIONS

CGPDTM	Office of the Controller General of Patents, Designs & Trade Marks of India
EAPO	Eurasian Patent Office
EP, EPO	European Patent Office
EPC	European Patent Convention
EU	European Union
IMPI	Mexican Institute of Industrial Property
INPI	Instituto Nacional da Propriedade Industrial – National Institute of the Industrial Property
IPC	International Patent Classification
JPO	Japan Patent Office
KIPO	Korean Intellectual Patent Office
OECD	Organisation for Economic Co-operation and Development
Rospatent	Russian Federation Patent Office (The Federal Service for Intellectual Property, Patents and Trademarks)
ROW	Rest Of the World
SIPO	Chinese State Intellectual Property Office
USD	United States Dollars
USPTO	United States Patent and Trademark Office
UN	United Nations
WIPO	World Intellectual Property Office

8. APPENDIX

8.1. APPENDIX TO CHAPTER 2 “OVERVIEW OF THE JAPANESE PATENT SYSTEM”

8.1.1. OTHER RELEVANT FEATURES OF JAPAN’S PATENT SYSTEM

Prior art reference disclosure

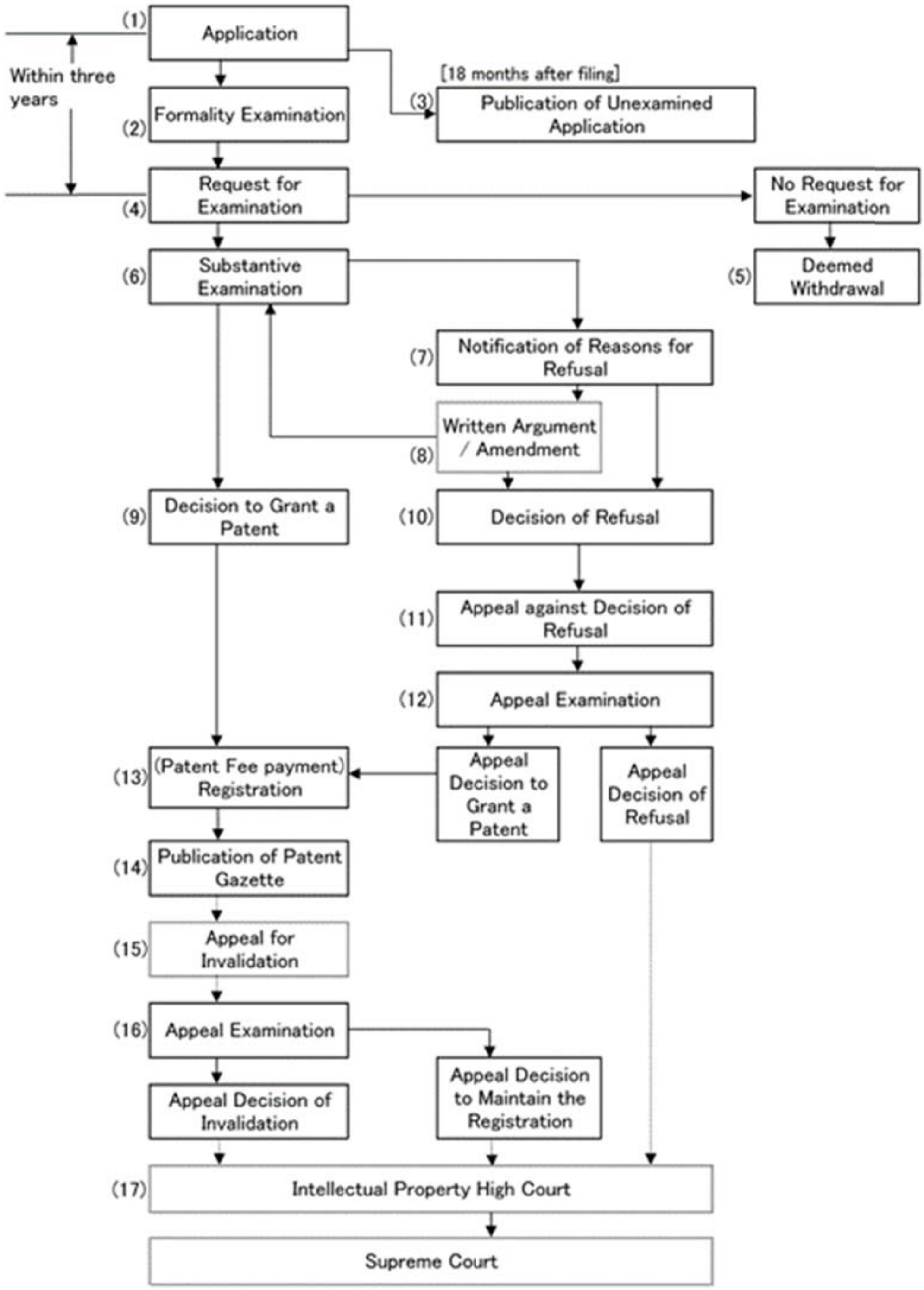
In September 2002, Japan adopted the prior art reference disclosure practice. According to this practice, applicants must file a detailed list of prior art references known at the time of the patent application. However, there are no associated penalties for failing to do so. It seems most applicants nevertheless list references extensively (Goto and Motohashi, 2007). The aim is helping patent examiners by addressing their prior art searches.

Citations

Japanese and European citation data are supplied by patent examiners while U.S. citations are mostly given by applicants and for this reason they differ in character. However, it should be noted that many of the citations contained in U.S. patents are given by patent attorneys working for applicants, and that USPTO examiners are part of the examination process. A significant numbers of citations at JPO and EPO are appointed to patent applications while for the U.S., the system of patent application publication was introduced only recently, so that only granted patents can be cited (Goto and Motohashi, 2007).

Flow chart of the patent procedure

Figure 14 Procedures for obtaining a patent right (source: JPO official website)



Examination and pendency period

Between 2004 and 2006, the number of pending applications at the patent offices of Japan and U.S. increased by 38%, while the number of pending applications at the EPO was stable. However, the increase in Japan, to a certain extent, is due to the change in the request for examination rule, shortened from seven to three years. The period of requests for examination has been changed from seven years to three years for the applications filed in and after October 2001, and the applications subject to a three-year request period began to reach the time limit for examination for making the request for examination from October 2004 onward, so that the requests for examination for these applications in order to determine the necessity of obtainment of a patent were concentrated on the final year of the period. This dramatically increased the number of requests for examination, and together with the request period, gave rise to a temporary surge, or "bump", in the number of requests for examination. Thus, the "bump in requests" seems to have passed its peak, as well as all applications with a seven-year request period reach the time limit for making the requests for examination before the end of September 2008, so that the number of the requests for examination in 2008 is expected to take largely downward turn.

The percentage of applications for which applicants requested examination was 55.8% in 1998. From 2002, due to the change in the period for request of examination, the rate of requests for applications should be considered under two points of view: the rate for the applications with a seven-year request period shifted between 50% and 60% while the rate for the applications filed from 2002 to 2004, that is with a three-year request period, remained from 65% to 70%. However, the number of requests for examination decreased slightly in last years: a 4% decrease over the 2005 level in 2006 and a 1.5% decrease over the 2006 level in 2007 (JPO, 2008).

This means that, more or less constantly, about one-third of applications are made public after 18 month of application but not requested to be examined at all. There are several reasons why inventors apply for patent and disclose its contents and not request examination. The inventor might realize that its invention would not be commercially successful or might want to apply and make it public knowledge in order to block other firms from patenting (Maskus and McDaniel, 1999).

According to the TSR (2008), in 2007, total pendency time in examination increased in all the three main offices: slightly at JPO and USPTO (to 32 months) while at EPO it increased by more than one month (to 45 months). One of the first priorities is therefore to improve the examination system and reduce the huge backlog of pending patents. At JPO some 800.000 applications were pending examination in 2003 whereas JPO was examining 200.000 applications a year on average.

The several initiatives JPO set to reduce the backlog, such as the hiring of 500 new examiners, the introduction of the outsourcing of prior art searches[73], a system of refunding in case of withdrawal prior to the first action and the increase in examination fees, are part of a greater "Plan for Acceleration of Patent Examination": the mid-term goal is year 2008, when examination period should be kept beneath 29 months; the long-term goal is year 2013, with a maximum pending time of 11 months; according to the real completion of the goals, the final goal is to reach real time examination (0 months). Achieving a real time patent examination system would significantly enhance R&D efficiency.

Besides the variation in the period of request for examination, there are other reasons which increased the burden of examination every year, such as the increasing number of international applications due to the filing of the same invention in different regions and the more complex and sophisticated content of applications and the increase in the number of international procedures[74].

In line with this increase in the number of applications awaiting the first action, the first action pendency has been lengthened from 25 months in 2003 to 27 month

[73] Applicants can submit search reports issued by certified entities together with patent applications. This could be possible also because the JPO has established a paperless system for all procedures, from the filing of an application to the examiner's decision. This has enabled active promotion of the world's first outsourcing of prior art searches to the private sector and has enhanced efficiency to a significant degree.

[74] In order to follow the rules of PCT procedure, Japan is involved both as destination country of a growing number of applications and as one of the eligible international authorities. Moreover there are many active programs trying to harmonize cross-national patenting procedures, such as PPH and New Route.

in 2007. All applications with a seven-year request period reach the time limit for making the requests for examination before the end of September 2008, so that the number of the requests for examination is expected to take largely downward turn in 2008. As a result, the number of applications awaiting the first action and the first action pendency are also expected to take a downward turn gradually. On the other hand, the rate of decisions to grant a patent lowered by 1.6% from 2003 to 2007.

Pre-grant disclosure

By laying open the application before it is granted, the Japan's patent system allows firms to make investment decisions with less uncertainty while preventing duplication of investments. Due to these procedural differences, inventions became public knowledge sooner and were quickly diffused into the research and scientific community in Japan (Maskus and McDaniel, 1999).

Moreover, there are no royalties until the issue of the patent. This implies, during the early disclosure period, that firms in Japan could extract technological knowledge from patent applications and file follow-on utility model and industrial design applications (Maskus and McDaniel, 1999).

Length of patent life

Until the middle of the 1990's, the duration of a patent in Japan was the shorter of 15 years from the date of publication for opposition or 20 years from the filing date. Given long pendency periods and examination delays combined with the term of protection beginning with the date of filing, the average term of protection was relatively short under the Japanese patent system (Maskus and McDaniel, 1999).

From the amendment of the opposition system in 1996, patent rights may extend for up to 20[75] years from the date of application (priority claim date) but many patents are abandoned before the end of this period. In Japan, over 50% of the patents granted are maintained for at least 17 years compared to at least 11 years for the European patents and at least 15 years for the U.S. patents. Among the Japanese patents, government-related ones are maintained longest. In fact, virtually all

[75] Some peculiar pharmaceutical patents could be maintained up to 25 years.

government-related patents were maintained until close to the end of the 20-year span, perhaps because government-owned patents are subject to patent fee[76] exemptions (Goto and Motohashi, 2007).

IP High Court and experienced lawyers

The IP High Court (*Chiteki-zaisan koutou-saiban-sho*) is a special semi-independent branch of Tokyo High Court in the judicial system of Japan. It is based in Kasumigaseki, a district in Chiyoda Ward in Tokyo. The IP High Court was established in 2005 and is composed by 18 judges in four divisions, which is equivalent to a medium sized High Court in Japan. The Judges are supported by 11 research officials, ten of whom have examiner/appeal examiner experience at JPO and one has experience as a patent attorney. These officials are required to review JPO's decisions and to submit a fair and accurate report to the Judges.

The IP High Court is the court of second instance, and the Supreme Court is the court of last instance in terms of legal interpretation. However the business community has requested the judiciary to form reliable rules and standards at an appeal stage, so that they do not have to wait for Supreme Court decisions.

The creation of the IP High Court is one of the recent changes aiming at improving the IP specialization degree and the ability to manage invalidity procedures. Worth of notice is the appointment of 140 technical advisers to assist the High Court and District Courts on technical matters. These advisers are university professors or researchers in public or private organizations who can be on support with their expertise when required. In parallel, in order to cope with the new complex IP reforms, patent lawyers are more specifically trained. The increase in patent attorneys with this new expertise is already marked; more than 500 *benrishi* (patent attorneys) have passed an examination that complies with a recent law allowing them to jointly and equally represent clients with attorneys at law (*bengoshi*). This changes the whole process of IP litigation in Japan, because *benrishi* are set to assume an important role in creating, protecting and utilising IP.

[76] Patent maintenance fees are set on a per year base with a fix amount plus a variable part related to the number of claims.

TLO – Promoting IPRs in Universities

Before the introduction of the Basic Law in 2002, professors could retain IPRs in university inventions. After that, Universities can adopt an IP policy to obtain IPRs in university inventions from professors. The same Law also fostered the creation of TLOs and the creation of IP divisions inside Universities.

Japanese TLOs date back to 1999, when the Law "Promoting University-Industry Technology Transfer" was enacted. Through its introduction, Japan followed and adapted TLO strategies used in the U.S. where they serve as engines for economic development by spinning out new companies and creating new employment opportunities and also favour the process of commercialising and transferring research results for public good and benefit.

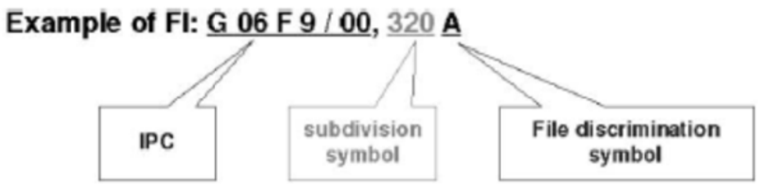
Japan adapted the TLO concept to 34 (mainly) University centres, in which approved TLOs are able to use national university properties without any cost (the centres were privatized in April 2004). The role of TLOs has expanded further from solely tech-transfer functionality to becoming centres that assist university start-ups and obtain patents. Moreover, this process resulted in a development unique to the Japan case: the creation of intra-university IP Divisions. These exist solely to give advice and support to those in universities who wish to bring their inventions to fruition.

The success of the Japanese TLOs may be seen in the rise in number of university start-up ventures in Japan. TLOs also play an important role as liaisons between academic institutions and corporations: for example, in 2003, TLOs successfully technology-licensed to corporations 1700 patents owned by academic institutions and, in the same year, TLOs have generated at least 5.5 million U.S. dollars in royalty income (Wada, 2005).

8.1.2. TECHNICAL DATA ON PATENT REGISTRATION

FI or "File Index" is the internal classification used by the JPO to classify the technical content of patent documents and to organise prior art searches more efficiently. More or less an extension of the IPC[77]. As shown in Figure 15, the FI classification is made up of a letter, denoting the IPC section, followed by a number (two digits), denoting the IPC class. A letter after the class denotes the IPC subclass, a number (variable, up to three digits) denotes the IPC main group, a forward slash ("/") followed by a number (variable, up to three digits), denotes the IPC subgroup. So far this describes any standard IPC classification symbol, but in addition, and specific to the FI classification, the IPC subgroup may be followed by an "IPC-subdivision symbol" which takes the form of a three-digit number. These IPC-subdivision symbols are special to FI classes and are structured hierarchically. Optionally, a "file discrimination symbol" in the form of a letter can be added (Schellner, 2002). With its various subdivisions, the FI classification has about 170.000 classes, whereas the IPC has only some 70.000 classes.

Figure 15 FI classification term structure

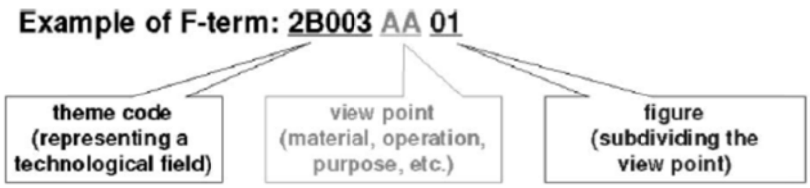


The Japanese system of F-terms ("File-forming Terms") is an internal subject indexing system applied to Japanese patent documents. The system is considerably more extensive than IPC, consisting of some 340.000 sub-divisions. The philosophy of application of F-terms is distinct from that of IPC classification. The latter seeks to classify the main inventive feature, whilst the former indexes the technologies used in the invention. F-term are only applied to Japanese documents, by personnel from the Industrial Property Cooperation Centre (IPCC), an independent body set up in 1985 and subsequently designated by law as the official outsourced contractor for Japan Patent Office search work (Adams, 2008).

[77] Since the launch of the eighth edition of the IPC in 2006, the Japanese FI system – originally based upon the fourth edition – has been modified to bring it more into compliance with the reformed system.

Being a completely independent classification system, F-terms classification is currently applied to patent documents in addition to the IPC and FI classifications. F-terms do not exist for all Japanese documents; coverage depends on the field of technology. Assignment of F-terms is largely based on the FI classification. F-terms are structured as it is shown in Figure 16, starting with a "theme code" which defines a broad technical field. Every theme code has a corresponding FI coverage. Themes are further split into terms ("term codes"). The second part of the theme code is typically a 4-character unit, consisting of a two-letter "view point[78]" or "aspect", followed by a two-digit extension, called the "figure". The combination of view point + figure is referred to as a "term code", although this 4-character[79] unit is sometimes referred as "the F-term" itself (Schellner, 2002; Adams, 2008). Term codes are in fact assigned according to various technical viewpoints (e.g. material, operation, product, purpose, etc.).

Figure 16 F-term classification - term code structure



The theme codes represent a partially-hierarchical division of subject matter, with the first two characters[80] indicative of the JPO examining division which will handle the case, and a further 3-character string which elaborates the field into a broad subject category. For example, theme codes with the prefix 5H represent the subject matter examined by the control and electric power generation examining division at the JPO.

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[78] There are typically 5 to 15 viewpoints per theme.

[79] However, there is provision for some term codes to be extended beyond the 4-digit unit, by the addition of further letters or symbols (sometimes referred to as "additive codes"). These extensions are not used in all theme codes.

[80] Referred to by some sources as a "theme group".

The number of documents which may be indexed by a given theme code is relatively small. This is usually in the range of 3000–5000. A single document will typically carry many more F-terms than corresponding FI or IPC classification marks, providing a much more detailed breakdown of the subject matter. Statistics from the end of 2006 indicated an average of 14 F-terms per document, but individual cases with 50 or more are not unknown.

The theme codes are constructed by recombining subdivisions from the Japanese FI classification. A single theme code may group together a contiguous range of FI terms or a non-contiguous set. The converse is also true; the range of subject matter covered by sequential FI subgroups may be allocated to different themes. The two systems are distinct and are developing in parallel. Approximately 800 theme codes have not been elaborated, and remain as so-called 'FI themes', with no corresponding term codes. In practice, the JPO examiners have found that the FI system provides sufficient precision for searching purposes in these subject areas, so no development of the F-terms has taken place. In the event that these technical fields become more complex or faster moving, and require the extra flexibility of a full F-term system, then the term codes can be developed within the existing theme.

8.1.3. UTILITY MODELS

Utility models are a special form of IPRs for inventions granted by a State to an inventor or assignee for a fixed period of time. The terms and conditions of granting a utility model are different from those for normal patents: shorter term and less stringent examination requirements. Utility models are an important alternative to patents in the countries where they are available because they allow and enhance incremental inventions of a small and applied nature that build on prior fundamental technical knowledge embodied in patent applications and that are quickly embodied in commercial uses (Maskus and McDaniel, 1999).

The number of applications for utility models varied very much in number through time. They were largely used from the 1960's and became one of the peculiarities of the Japanese IP system. The amount of domestic applications for utility models tripled between 1960 and 1987 before falling sharply, presumably because the elimination of the single-claim requirement in patents reduced the relative attractiveness of utility models. With the same trend, foreign applications reached a high in 1970 before declining to levels below 1.000 per year at the end of the 90's. Domestic applications were about 98% of total applications for utility models (Maskus and McDaniel, 1999). From the 1990's until 2004 the utility models demand had been decreasing, so discussion whether to keep utility models format alive or not was one of the main issue in IP policy. In 2004 it was decided to modify the terms and costs of this IPR. The main 2004 amendments are:

- extension of the term of utility model right: from "six years from the filing" to "ten years from the filing";
- reduction in the annual fee for utility model right;
- ability to file a patent application based on a utility model registration within three years from the filing of the utility model application.

After a first short boost in the request, the demand for utility models started again to slowly but constantly decrease[81]. In recent years, applications and grants for utility models in Japan settled on 10 - 12.000 per year with a resident share around 80%.

[81] A similar decrease has been observed in many of the countries where utility models are issued (for example Germany and the Republic of Korea).

8.2. APPENDIX TO CHAPTER 4 "INTERNATIONAL PATENT ACTIVITIES: PATENT EXPORT FROM EUROPE, USA, JAPAN, CHINA, SOUTH KOREA, INDIA, BRAZIL, MEXICO AND RUSSIA"

8.2.1. DATA COVERAGE AND PECULIARITIES

World Offices have their own peculiar procedure to store and publish patent data and in some cases they have changed it from certain points in time. Similarly, the world POs report data to EPO with no commonly defined scheme in terms of format and timing. The reasons and the magnitude of these structural limits are not always clearly evident but whenever they have been recognized in this study, they have been highlighted. Here some insights on the most evident cases are provided along with clarifying notes on the methodology applied to collect the corresponding data. Additional information were received from the EPO personnel to understand some of the reasons behind unclear data trends.

EPO

As a regional office, the EPO has peculiar characteristics compared to the other examined POs. In the analysis, the documents which have been connected to the EPO are those issued by the EPO itself (coded as "EP" in EPODOC) and those issued by the POs which are member of the European Patent Convention (EPC) and which constitute the European Patent Organisation. To cope with this feature, we opted for the "EPO" item, grouping all the member states. Since the EPC countries increase through time, we considered each country being part of the EPO item starting from the defined year, if its adhesion to the EPC dates before July 1st of that year. For example, in 1991, the "EPO" group includes the patent documents of Belgium, Switzerland, Germany, France, United Kingdom, Luxembourg, The Netherlands, Sweden, Italy, Austria, Lichtenstein, Spain, Greece and Denmark (and all those coded as "EP" directly issued by the EPO); in 1992, the "EPO" item aggregates the 1991 members and Monaco (even if it was member since December 1991) and Portugal; and so on until 2005 (30 member states).

India

The analysis of EPODOC patent applications at the India PO reveals a growing trend until 1995, while after 1995 the number of filings crumbles down to only one application per year. This seems due to a lack of data from India in EPODOC: the comparison of the number of patent applications in India among different data sources[82] shows that Indian applications are more than those found in EPODOC from 1995 to 2005. It is likely that the PO of India have not transferred recent data to the EPO yet. Information retrieved from EPO personnel confirm that there have been some delays in the exchange of electronic data between the POs and that some publication codes referring to India might have been created from the citations found in other patents. The related applications therefore might be missing. The gaps in the "IN" collection will be filled in at some point in the near future due to recent agreements between the two POs. The problem described here affects all the statistics having India as destination country: they are underestimated.

Mexico

Patent applications filed in at the Mexico PO show a very oscillating trend which is suspected to be not perfectly representative of the real situation, especially until 2001. The comparison with the WIPO database helps only partially. More information comes from the EPO personnel who reports that the loading of the Mexican front file bibliographic data was interrupted years ago for technical reasons related to the data exchange procedures: the changes caused delays in the adaptations of the routines to import data from IMPI. Anyhow, all the processes have been completed and front file data should have started to be loaded again. The flows towards Mexico might be under- or overestimated in certain years.

Russian Federation

Historical reasons, such as the political and territorial change from Soviet Union to Russian Federation at the end of 1991 and the reform of the Russian patent law

[82] Several Annual Reports from the official India PO website (www.patentoffice.nic.in), WIPO statistics (http://www.wipo.int/ipstats/en/statistics/patents/) and preliminary queries based on publication code instead of application code from EPODOC and PATSTAT databases.

which dates back to 1992, are behind the steep drop in patent applications at the beginning of the 90's.

It is worth to remind that in this study the values inherent Russian patents include the former Soviet Union (coded "SU") and the EAPO (coded "EA") applications, even if Rospatent and EAPO are two separate Offices, both located in Moscow, and have so two different data exchange process with the EPO.

United States of America

The USPTO started publishing patent applications since March, 2001. Before that date, the only public available information was on granted patents: for this reason the flows to U.S. until 2001 are underestimated.

This distortion affects the analysis of the trends directed to U.S. until 2001 as it appears from the comparison with the last years of the period of analysis: 2002 – 2005.

PCT procedure

Patent applications filed at the WIPO, that is those requesting PCT procedure, are coded "WO" in EPODOC. Regardless of the procedural phase they have reached[83], "WO" patent applications are taken into consideration in the export analysis of each PO. They have been added to the totals of "The Rest of the World" group. The export through PCT route has not been analysed and resolved according to the end country. This definition implies that for some POs where the PCT route is used massively as export way, it might results the wrong impression that the rest of the world gets more patent than the other eight POs. However a large part of the PCT applications goes back to the eight POs.

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[83] It is not in the objectives of this study to tackle in details the peculiarities of the PCT procedure: for a more detailed technical explanation please refer to the official WIPO website (http://www.wipo.int/).

8.3. APPENDIX TO CHAPTER 5 “PATENT QUALITY: AN EMPIRICAL ANALYSIS OF PATENT OPPOSITIONS AT THE EPO”

8.3.1. THE QUESTIONNAIRE ON PATENT QUALITY

The questionnaire was divided into five sections. Those companies and PROs that do not own any patents are allowed to fill in the first section and some key questions of the second, but they are subsequently redirected to a different set of questions aiming at assessing the possible reasons behind their choice not to patent their inventions. The different sections for patentees are the following:

- Section 1 – Company or PRO data: size, volume of current patent portfolio, geographical extension of final market, main technological sector and R&D investment intensity.
- Section 2 - Usage of the patent system: Information on the involvement in the patent system and firms usual procedures when applying for patents, including questions asking for a definition of patent quality and a rating of the quality of the European patent system, according to different perspectives (the components of quality are separated between those relating to legal compliance, the pre-grant process, and the systemic dimension of patent quality)
- Section 3 - The quality of the patent system concerning the search and examination process: perceptions of the quality of the search and examination process at the European Patent Office, of the fee structure and of the translation costs.
- Section 4 - The quality of the patent system concerning the enforcement of granted patents: Opinions on features related to the enforcement of granted patents, such as the most frequent typologies of infringement, the effectiveness of the current patent litigation system in Europe and the most important sources of inefficiency.
- Section 5 - Proposals for the improvement of the quality of the European patent system: Views and their expectations about a set of relevant policy initiatives,

such as the introduction of the European Union Patent, the peer-to-patent review or the “raising the bar” initiative.

The questionnaire was disseminated through a web platform; access was granted by sending a unique personal link to each respondent via an invitation email. The possibility to join the consultation was promoted through the support of European industry associations. About 100 associations were contacted to circulate the flyer among their members to give the survey the widest diffusion. Furthermore, the survey was advertised by the IPR HelpDesk website and DG Research of the European Commission sent a communication to all the recipients of grants within the 7th Framework Programme (FP7). The database of firms and PROs was enriched by including the email addresses of some additional relevant companies from four sources: the TNO Innovation Policy Group dataset, which includes mainly SMEs from all over Europe; the 2008 top EPO applicant list limited to Europe-based companies; a sample of the top 1,000 EU companies as reported in the 2008 EU Industrial R&D Investment Scoreboard; and a sample of firms randomly extracted from the complete list of European assignees of patents granted in 2008 by the EPO. For all of these companies and PROs the email addresses were mainly identified from each organisation’s official website.

The guiding strategy in disseminating the questionnaire was to give the largest number of companies and PROs the chance to express their opinions on the quality of the European patent system. For this purpose, no stratification checks or stratified re-sampling were carried out. Hence, the final sample cannot be intended as representative of the European population of firms, from a standard statistical approach. The questionnaire requires a rather deep knowledge of the patent system, which might not be commonly spread even among patent holders, especially if they rely heavily on the activities of third parties, such as patent attorneys and law firms, for the management of their IP portfolio. While this might have reduced the number of respondents, it allowed us to collect extremely valuable and in-depth information on the perceived quality of the European patent system.

8.3.2. THE OPPOSITION PROCESS

The opposition procedure and the appeals process are regulated by the European Patent Convention (EPC) in Parts V and VI, respectively. An opposition notice has to be filed within nine months of the grant of the patent by the EPO (art. 99, EPC). The patent may be opposed by third parties (for example the applicant's competitors) if they believe that it should not have been granted. The main reason for opposing a patent is that it does not meet conventional patentability criteria: novelty, inventive step and commercial applicability. Other admissible reasons for an opposition are that disclosure of the invention is not sufficiently clear and complete to enable other people skilled in the art to perform the invention and that the scope of the patent as granted extends beyond that of the original application (art. 100, EPC). The opponent will have to substantiate the opposition by presenting evidence that the above prerequisites for patentability are not fulfilled.

The notice of opposition is examined by the Opposition Division at EPO. The Opposition Division consists of three experienced examiners, one of whom may have been involved in the examination phase. Once the opposition has been filed, settlement options between the opponent and the patent holder are restricted (rule 60, Implementing Regulations to the Convention on the Grant of European patents). This feature differentiates the EPO's centralised opposition procedure from ordinary litigation before civil courts. In fact, if opposed parties and opponents decide to settle their case after the opposition has been filed, and the opponent, for example, withdraws its attack, the EPO may still continue to decide on the case.

The conclusion of the opposition proceedings can lead to the following outcomes: the opposition is rejected and consequently the patent is upheld without amendments, the patent is revoked, or the patent is amended (art. 101, EPC). In this last case, a new modified version of the granted patent is published by the EPO. Normally, an amendment results in a reduction of the "breadth" of the patent: the patent is narrowed by modifying the claims that delimit the area in which exclusive rights are sought.

Any decision made by the Opposition Division can be subsequently appealed (art 106, EPC). Therefore, both patent holders and opponents may file an appeal against the outcome of the opposition procedures. The appeal has to be filed within two months from the decision of the Opposition Division and it has to be sustained within an additional two months. The median duration for appeal cases is two years. The Court of Appeal is the body in charge of the final decision on the validity of the contested EPO patent. In case the Court of Appeal supports the decision taken by the Opposition Division, opponents can lastly try to attack the succeeding national patents in each designated state in which the patent is valid. However, aside from the high costs implied, the probability of winning a validity suit in a country after having lost at the European level is very low because the arguments brought forth in previous trials are usually exploited by national judges. Of course, after being granted, a European patent can be attacked by third parties through legal means allowed for by the respective national legislations in which the patent is valid. In this case, if a patent is invalidated in one country, this outcome will not affect the other jurisdictions in which the patent is in place. The opponent will have to sue the patent holder in all of the states in which patent protection is sought. To attack the patent in all of the designated states is, however, very expensive, and differences in the national patent jurisdictions may make patent validity suits complicated and uncertain. Costs for litigation in any one of the national courts have been estimated to be between 50,000 and 500,000 Euros, depending on the complexity of the case (Harhoff and Reitzig, 2004). On the other hand, the central opposition procedure implies lower costs and the decision on the opposition has force in all designated EPC countries. The costs of opposition and appeal are borne by each of the parties involved (art.101, EPC). Harhoff et al. (2007) report, based on interviews with patent attorneys, that the cost per instance and per party for an opposition is in the range of 15,000-25,000 Euros. Approximately the same amount is due for an appeal against the outcome of the opposition proceedings.

8.3.3. GRANTS AND OPPOSITIONS: INDUSTRY BREAKDOWN

Table 20 reports the number of patent grants and oppositions filed, as well as the opposition rate, across different technology areas during the years 2000-2008. Pharmaceuticals, transport, medical technology and other special machines are those sectors with the highest number of oppositions filed in absolute terms. However, if we consider the opposition rate heterogeneous patterns can be appreciated. In particular ICT related fields show lower average opposition rates compared to other areas such as basic materials chemistry (10.12%), materials, pharmaceuticals (8.71%), surface technology, coating (8.62%) and macromolecular chemistry, polymers (8.49%).

Table 20 EPO patent grants and oppositions across different technology fields (years 2000 - 2008)

Technology fields	% of granted patents	% of oppositions	Opposition rate
Audio-visual technology	3.09	1.45	2.48%
Basic communication processes	1.19	0.17	0.73%
Basic materials chemistry	2.44	4.69	10.12%
Biotechnology	2.39	3.06	6.75%
Chemical engineering	2.7	3.82	7.47%
Civil engineering	3.05	3	5.19%
Computer technology	4.57	1.65	1.90%
Control	1.32	1.57	6.25%
Digital communication	2.01	0.52	1.37%
Electrical machinery, apparatus, energy	4.7	3.16	3.55%
Engines, pumps, turbines	3.73	2.85	4.03%
Environmental technology	2.28	2.17	5.02%
Food chemistry	1.26	3.36	14.02%
Furniture, games	2.15	1.91	4.67%
Handling	3.83	4.27	5.87%
IT methods for management	0.14	0.17	6.58%
Machine tools	3.61	4.42	6.45%
Macromolecular chemistry, polymers	2.58	4.15	8.49%
Materials, metallurgy	2.13	3.63	9.01%

Technology fields	% of granted patents	% of oppositions	Opposition rate
Measurement	4.98	3.48	3.68%
Mechanical elements	3.54	2.86	4.26%
Medical technology	5.71	6.22	5.74%
Micro-structural and nano-technology	0.09	0.02	0.97%
Optics	3.41	1.19	1.84%
Organic fine chemistry	2.9	2.23	4.05%
Other consumer goods	2.07	2.61	6.64%
Other special machines	4.27	6.14	7.58%
Pharmaceuticals	4.99	8.25	8.71%
Semiconductors	1.28	0.3	1.24%
Surface technology, coating	1.73	2.82	8.62%
Telecommunications	3.49	1.12	1.69%
Textile and paper machines	3.81	4.66	6.46%
Thermal processes and apparatus	1.15	1.16	5.30%
Transport	6.96	6.76	5.12%
Organic fine chemistry	0.45	0.22	2.57%
Total	100	100	5.28%

8.3.4. CHARACTERISTICS OF OPPOSED PATENTS

Table 21 reports the mean, median, standard deviation and minimum-maximum values for the following variables: backward and forward citations, references to the non-patent literature and patent claims. Forward citations show a mean value that is higher for the group of opposed patents. The mean number of references to the patent and non-patent literature and of claims is higher for the sub-sample of opposed patents.

Table 21 Descriptive statistics on the number of backward and forward citations, references to the non-patent literature, number of claims (entire sample, sub-samples of opposed and unopposed patents)

	Entire sample	**Opposition=1**	**Opposition=0**
Number of references to patents (backward citations)			
Mean	4.62	5.57	4.56
Median	4	5	4
St.Deviation	3.21	3.84	3.17
Min-Max	0-152	0-99	0-152
Number of references to the non-patent literature			
Mean	1.47	1.77	1.45
Median	1	1	1
St.Deviation	2.18	3.01	2.12
Min-Max	0-105	0-105	0-75
Number of citing patents (forward citations)			
Mean	0.09	0.23	0.08
Median	0	0	0
St.Deviation	0.62	1.00	0.59
Min-Max	0-67	0-31	0-67
Number of claims			
Mean	12.71	14.37	12.62
Median	10	12	10
St.Deviation	9.09	10.35	9.01
Min-Max	1-247	1-147	1-247

As it is evident from Table 22, the incidence of opposed patents increases with the number of forward citations. The group of patents receiving from seven to nine citations is attacked in 22.66% of the cases, more than four times more than the patents that were not cited at all. This probability slightly decreases to 16.04% when forward citations exceed the number of 9. It is therefore clear that patents are attacked far less frequently if they receive few or no forward citations, namely, if they are less valuable. Patents that are attacked most frequently, in 10.47% of the cases, display a number of backward citations larger than 9.

Table 22 Descriptive statistics on the number (and percentage incidence) by number of forward and backward citations

	Number of granted patents	Number of opposed patents	Incidence of opposed patents
Number of forward citations			
0	435,794	21,540	4.94%
1-3	21,363	2,360	11.05%
4-6	1,242	207	16.67%
7-9	278	63	22.66%
>9	293	47	16.04%
Number of backward citations			
0	14,092	351	2.49%
1-3	165,156	6,848	4.15%
4-6	191,293	10,052	5.25%
7-9	61,850	4,184	6.76%
>9	26,579	2,782	10.47%

The relationship between the likelihood for a patent to be opposed and the number of backward citations, although weaker than in the case of forward references, has two possible explanations: first, the higher the number of backward citations included by the examiner, the higher the likelihood that the innovative contents of the patent under examination rely on previous innovations and hence, the actual inventive step is more questionable. Second, more backward citations to the previous patent literature increase the probability that the owners of cited patents become aware of the newly granted patent and decide to file an opposition.

From Table 23 it results that Denmark ranks first in terms of opposition frequency across the years. The Netherlands, Germany and Sweden follow, respectively ranking second, third and fourth. It must be noted that differences in opposition rates may be due also to different patent-sectoral affiliations: multivariate analysis considers the relevance of both components.

Table 23 Opposition rates across different priority countries and years.

	Opposition rate				
First priority country	**2000-2008**	**2000-2002**	**2003-2004**	**2005-2006**	**2007-2008**
Germany	6.87%	6.73%	6.87%	6.95%	6.93%
USA	5.06%	5.09%	5.06%	5.25%	4.84%
EPO	5.77%	6.21%	6.51%	5.60%	5.20%
Japan	2.72%	3.17%	2.99%	2.51%	2.23%
France	4.93%	5.35%	4.94%	4.98%	4.40%
Great Britain	6.11%	5.75%	5.70%	6.50%	6.63%
Italy	5.29%	5.57%	4.90%	5.12%	5.65%
Sweden	6.47%	6.64%	6.56%	6.48%	6.13%
Netherlands	9.87%	10.55%	8.83%	11.54%	8.55%
Denmark	11.54%	11.04%	9.63%	12.66%	13.14%

To examine whether or not the patent-granting process takes longer for patents that are later subject to an opposition, we calculated the time lag (in days) that occurs between the date of the application at the EPO and the granting date of the patents in our sample (Table 24). Unopposed patents show on average a longer duration of the granting process relative to opposed ones. However, differences in absolute terms seem to be rather small. The average time lag between the date of the first application and the granting date is 19 days longer for unopposed patents, and the median value is 47 days. A longer time lag between the date of the first application and the granting date occurs among unopposed patents in Electrical Engineering and Other Fields, and this difference is significant at the 5% level. However, it seems that the duration of the granting process is higher for opposed patents in Chemistry and Instruments, respectively at 10% and 5% levels of significance. In the Mechanical Engineering sector, we do not find statistical evidence of a difference in the durations.

Table 24 Descriptive statistics on the difference in the time lag (in days) that occurs between the date of the first application and the granting date across the sub-samples of opposed and unopposed patents.

	Δ days (not opposed-opposed) 2000-2008	**Δ days (not opposed-opposed) 2006-2008**
Mean	19.31	21.46
Median	47	28.5
10th centile	6	1
25th centile	16	2
75th centile	29	59.25
90th centile	-3	1

8.3.5. OUTCOMES OF OPPOSITIONS: METHODOLOGY AND DESCRIPTIVE STATISTICS

The Thomson Innovation database does not provide explicit information on the outcome of the opposition. However, the final outcome can be inferred from INPADOC Legal Status codes. INPADOC, which stands for International Patent Documentation Centre, is a database maintained by the European Patent Office that contains legal status information on patents issued by the EPO. For all granted patents in the period 2000-2008, we retrieved the INPADOC legal status as of 31st January 2010, from the INPADOC Patent Gazette. There are some INPADOC codes that can enable us to retrieve information on the outcome of opposition proceedings:

› EP27A (amended). The patent is maintained as amended, given the amendments made by the proprietor during the opposition proceedings.

› EP27W (revocation). In the case that the Opposition Division is of the opinion that the grounds for opposition mentioned in Art. 100 EPC do prejudice the maintenance of the patent, it revokes the European patent, taking effect in all contracting states.

› EP27O (opposition rejected). In the case that the Opposition Division is of the opinion that the grounds for opposition mentioned in Art. 100 EPC do not prejudice the maintenance of the non-amended patent, it rejects the opposition. The European patent remains in force in its original form from the date of grant.

› EP27C (termination of the opposition procedure). In case of surrender or lapse in all contracting states of a European patent for which opposition proceedings are pending, within two months of the notification date, the opponent may file a request for the continuation of the proceedings. If no such a request is made, the opposition proceedings are automatically terminated.

In the dataset, there are also oppositions for which we do not have evidence of any of the three outcomes discussed above. This residual category mainly includes cases in which the opposition is still pending. Table 25 reports the number and percentage of incidence of the outcome of the oppositions for the sub-sample of opposed patents across the years. We do not consider the last two years (2007-2008) because the incidence of still pending cases is too high.

Table 25 Outcome of the opposition process over time (2000-2006), by year of granting of the opposed patents

Outcome (%)	**2000-2006**	**2000-2002**	**2003-2004**	**2005-2006**
amended	19.45	31.3	20.14	9.41
rejected	14.05	19.94	14.38	8.02
revoked	24.92	32.91	26.94	15.13
terminated	7.11	7.66	7.39	6.29
residual	34.47	10.36	31.16	61
Total	100	100	100	100