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Working Party of National Experts on Science and Technology Indicators

OECD PATENT MANUAL 2008

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The OECD Patent Manual 2008 is an in-depth revision of the 1994 edition. This draft has gone through several reviews: by the Patent Statistics Task Force, made up of the European Patent Office (EPO), the Japan Patent Office (JPO), the US Patent and Trademark Office (USPTO), the World Intellectual Property Organisation (WIPO), Eurostat, and the US National Science Foundation (NSF); and by a group of experts including NESTI delegates and academic researchers. The OECD Patent Manual 2008 is submitted to NESTI for decision regarding its publication as part of the Frascati Manual series.

Contacts:
Pluvia Zuniga Lara (OECD/DSTI/EAS); E-mail: maria-pluvia.zunigalara@oecd.org
Dominique Guellec (OECD/DSTI/EAS); E-mail: dominique.guellec@oecd.org

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OECD Patent Manual 2008

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CHAPTER 1

OBJECTIVES AND SCOPE OF THE MANUAL

1. The aim of this manual is to provide basic information about patent data used in the context of science and technology (S&T) measurement, construction of indicators of technological activity, and guidelines for the compilation and interpretation of patent indicators in this context.

2. Alongside other science and technology indicators such as R&D expenditure and personnel, innovation survey data and so on, patents provide a uniquely detailed source of information on inventive activity. Patent data are complementary to other S&T data. It is generally useful to use several types of data in conjunction (R&D, innovation, patents), for the sake of cross-validation and to help interpretation. All these indicators have their strengths and weaknesses; they also reflect various stages in the innovation process. This manual is part of the "Frascati" family of OECD manuals, others being the *Frascati Manual* on R&D, the *Oslo Manual* on innovation, the *Technology Balance of Payments* (TBP) Manual, and the *Canberra Manual* on human resources.

3. Patent statistics have been used to assess S&T activities for a long time. Widely reported work was carried out in the 1950s by Jakob Schmookler, a US scholar, who used patent counts as indicators of technological change for particular industries. The use of patent data expanded in parallel with the power of computers. The OECD held a conference on new S&T indicators in 1985, where patent statistics were at the core of several presentations. Over this period S&T publications increasingly included a section on patent indicators. Reflecting the broadening use of patent data by academics, the famous scholar Zvi Griliches published in 1990 a now classic paper assessing the ways to use such data. The OECD published its first Patent Manual in 1994. At the same time, patent offices were expanding their efforts to monitor patenting activity with extensive statistics. Several companies have flourished in selling patent-based business intelligence using an extensive statistical approach. Data increasingly became available electronically, and the EPO Worldwide Patent Statistics Database ("Patstat"), which gathers data from almost all patent offices in the world in a standardised format, was published in 2006 by the European Patent Office.

4. Patents are a means of protecting inventions developed by firms, institutions or individuals, and as such they may be interpreted as indicators of invention. Before an invention can become an innovation, further entrepreneurial efforts are required to develop, manufacture and market it. Patent indicators convey information on the output and processes of inventive activities. Patents protect inventions and, although the relationship is not simple, much research has shown that after applying the proper controls there is a positive relationship between patent counts and other indicators related to inventive performance (productivity, market share, etc.). The relationship is not necessarily simple, as it can vary across countries, industries and over time. With the information reported in patent documents, the statistical exploitation of these data offers unique insight into invention processes. Patents provide information on the technological content of the invention (notably its particular technical fields), and the geographical location of the inventive process. As they identify the owner and inventors, when matched with complementary data

patents can illustrate the organisation of the underlying research process (*e.g.* alliances between firms or between firms and public research organisations, the respective role of multinationals and small firms, size and composition of research teams, etc.). Patents can also provide information about inventors' mobility and networks, and they allow knowledge diffusion to be tracked (the influence of particular inventions on other, subsequent inventions).

5. Another advantage of patent data is broad availability at relatively low cost. Patent data are administrative data. Patent databases are compiled by patent offices for internal purposes to manage their administration of patent examinations, and most notably to fulfil their mission of information dissemination. They are available on the Internet for public consultation. Adapting these databases for statistical use requires some further investment, but such databases are available quite broadly now. The reduction in computer costs makes it easier to use these data on a large scale and in decentralised and open way. No confidentiality rules forbid access to published patent information, although publication generally takes place 18 months after the first filing. As a result, patent data are publicly available for most countries across the world, often in long time series.

6. Patent indicators have drawbacks as well, which is why they must be used and interpreted with caution. Not all inventions are patented. Companies can prefer secrecy, or rely on other mechanisms in order to gain their market dominance. There is evidence of differing patenting behaviour across industries and countries and over time. The value distribution of patents is known to be skewed, as a few have very high technical and economic value whereas many are ultimately never used. Simple counts, which give the same weight to all patents regardless of their value, can therefore be misleading notably in the case of small samples. Different standards across patent offices and over time impact patent numbers although underlying inventive activities could stay unaffected.

7. Patent data are complex. It is necessary to have precise knowledge of patenting laws and procedures and the patenting behaviour of companies so as to apply proper controls and filters to the data in order to obtain meaningful indicators and interpret them correctly. The complexity of patent data is due to various factors, *e.g.* the diversity of patent offices and procedures (which can be national or regional in their judicial scope); the availability of various routes to file for patent protection (national or international) and the changing behaviour of applicants in this regard; and differing status and dates in a patent document in relation to the complexity of procedures (applications, grants, international phase, etc.).In addition, some patent information may still be under discussion among experts (value indicators, number of citations/claims, etc.).

8. With the burgeoning of patent-based statistics, it is necessary to share knowledge on how to use the data, and to develop standards that will improve the quality of indicators and reduce the scope for possible misinterpretation. For instance, it is still common for analysts to compare patent counts from different patent offices to assess countries' performance, whereas such counts are usually not directly comparable. This manual *i)* provides background information necessary to understand or to compile patent-based statistics; and *ii)* proposes standards (formulae for indicators and vocabulary) for compiling patent indicators. However, standards are proposed only in areas where some consensus has been reached among experts. In certain areas, notably the most recent ones, no such consensus has yet emerged, and this manual will instead mention the various options. The target audience of the manual is :*i)* users and compilers of patent statistics in statistical agencies and S&T agencies; and *ii)* users of patent databases who conduct analytical work on the dynamics of technology at the company, regional or national level.

9. This manual is a revised version of the 1994 OECD Patent Manual ("*The Measurement of Scientific and Technological Activities: Using Patent Data as Science and Technology Indicators"*), which marked a first step in the process of clarifying and harmonising patent-based indicators. It described the legal and economic background of patents – a necessary step before designing statistics – and listed

indicators that could be constructed from patent databases. It also listed a number of methodological problems encountered when calculating indicators based on patents. Since 1994, the experience in using patent data has developed substantially, and it is the ambition of this revised version of the manual to take stock of that experience. The manual reflects notably, but not exclusively, the experience of the OECD and members of the Taskforce on Patent Statistics in developing statistical standards for compiling patent indicators for measuring inventive activity. Members of this task force are: the European Patent Office (EPO), the Japan Patent Office (JPO), the US Patent and Trademark Office (USPTO), the World Intellectual Property Organisation (WIPO), Eurostat, and the US National Science Foundation (NSF).

10. Today, most if not all national and international S&T statistical reports include a section on patents (see Box 1.1). At the same time, an increasing number of policy reports use patent data to monitor developments in particular technical or institutional fields. A new field of academic research has emerged and expanded making use of patent data.

11. This manual is structured as follows. Chapter 2 addresses the meaning of patent indicators: the legal foundations, the economic dimension, the information contained in patent documents, and the type of analytical questions that patent indicators can address. Chapter 3 details patenting procedures, focussing on Europe, Japan, the United States and the international procedure (Patent Co-operation Treaty). Chapter 4 reports the general rules that apply when compiling patent indicators: reference date, reference country, international vs. national patent applications, and patent families. Chapter 5 describes the various classifications which can apply to patents: technical field, industry, institutional sector, and region, and reviews methods of attributing patents to particular companies or inventors. Chapter 6 deals with patent citations: their meaning and their use in indicators. Chapter 7 reviews patent-based indicators of the internationalisation of S&T activities. Chapter 8 discusses indicators of patent value, such as renewal, family size, number of technical classes, etc.

Box 1.1. A sample of regular patent statistics

I. S&T publications

United States (2006): Science and Engineering Indicators (National Science Foundation)

- Granted patents to US and Foreign Inventors by country/economy of origin
- Top patenting corporations

Japan (2004): Science and Technology Indicators (National Institute of Science and Technology Policy – NISTEP)

- Number of domestic and foreign patent applications originating in selected national patent offices.

France (2006): Observatoire des Sciences et Techniques : Indicateurs de sciences et de technologies 2006

Eurostat (2007): Statistics in Focus, statistical books and pocket books on Science, Technology and Innovation in Europe

- EPO and USPTO patents, by country, by regions.
- Triadic patent families

OECD (2007): Compendium of Patent Statistics, OECD

- Triadic patent families
- ICT, biotechnology and nanotech patents (PCT)
- Cross-border ownership of inventions, cross-border co-inventorship in patents.

II. Patent offices and related organisations

Patent offices publish regular reports reflecting mainly their own activity (applications, grants etc. with various breakdowns).

WIPO Statistics (2006): PCT Statistical Indicators Report

PCT International Applications (by origin, language of filing, technical field)
PCT International Applications by Receiving Office

Trilateral Statistical Report (Yearly): EPO, JPO and USPTO

- Patent activity by blocs: first filings, origin and targets of applications, grants
- Inter-bloc Activity: Flows of Applications, Patent Families
- Filing of PCT applications by year of filing, trilateral patent families

European Patent Office: Annual Report

Japan Patent Office: Annual Report

US Patent and Trademark Office: Patent Statistics Reports

CHAPTER 2

PATENTS AS STATISTICAL INDICATORS OF SCIENCE AND TECHNOLOGY

2.1 Introduction

12. The statistical properties of patent data are determined by their legal characteristics and by their economic implementation as these influence which inventions are protected, by whom, what information is disclosed (hence made accessible to statisticians), how much important are patents for industries, etc. This chapter provides an overview of the legal and economic foundations of patents. It describes the basic concepts necessary to the use of patent as indicators of science and technology.

2.2 Legal foundations of patents

13. Patents are legal instruments used in economic life. A patent is a legal title protecting an invention (Article 28 of the Trade-Related Intellectual Property Rights (TRIPS) Agreement):

"*I*. A patent shall confer on its owner the following exclusive rights:

(a) where the subject matter of a patent is a product, to prevent third parties not having the owner's consent from the acts of: making, using, offering for sale, selling, or importing for these purposes that product;

(b) where the subject matter of a patent is a process, to prevent third parties not having the owner's consent from the act of using the process, and from the acts of: using, offering for sale, selling, or importing for these purposes at least the product obtained directly by that process.

II. Patent owners shall also have the right to assign, or transfer by succession, the patent and to conclude licensing contracts."

14. Patents grant their owner a set of rights of exclusivity over an invention (a product or process that is new, involves an inventive step and is susceptible of industrial application) as defined by the "claims". The legal protection conferred by a patent gives its owner the right to exclude others from making, using, selling, offering for sale, or importing the patented invention for the term of the patent, which is usually 20 years from the filing date, and in the country or countries concerned by the protection. This set of rights provides the patentee with a competitive advantage. Patents can also be licensed or used to help create or

finance a spin-off company. It is therefore possible to derive value from them even if their owner does not have its own manufacturing capability (*e.g.* universities).

15. Patents are temporary rights, valid for a maximum of 20 years after the date of application, after which the invention they protect falls into the public domain.[1] Patents are territorial rights; they only apply to the country for which they have been granted. For instance, a patent granted in the United States will not confer exclusivity in Japan – it will only prevent the patenting of the same invention in Japan (as worldwide novelty is required to obtain a patent). Patents are granted to inventions from all fields of technology. In general, laws of nature, natural phenomena and abstract ideas are not patentable (there is of course debate about the boundaries of the system – *e.g.* is software an "abstract idea" or is it a patentable invention?).

2.3 Administrative routes for protection

16. Patents are obtained after following specific administrative procedures.[2] In order to obtain a patent, the inventor has to file an application to a patent office which will check that the invention fulfils the relevant legal criteria, and will grant or reject it accordingly. There are different alternative "routes" for protection available to inventors, who will choose one depending on their national or world-wide business strategy.

- ***National route.*** When an inventor (an individual, company, public body, university, non-profit organisation) decides to protect an invention, the first step is to file an application with a national patent office (generally the national office of the applicant's country). The first application filed worldwide (in any patent office) for a given invention is known as the "*priority application*", to which is associated a "*priority date*". The patent office then begins "searching and examining" the application in order to check whether a patent may be granted or not, *i.e.* whether the invention is directed to patentable subject matter, is novel, inventive ("non-obvious to persons skilled in the art") and capable of industrial application. The application is generally published 18 months after it is filed (*publication date*). The time lag between filing and grant or refusal of patents is not fixed; it ranges from two to eight years, with significant differences across patent offices.

- ***International route.*** Since 1883, when procedures were standardised under the Paris Convention (about 170 signatory countries in 2006), applicants who wish to protect their invention in more than one country have 12 months from the priority date to file applications in other Convention countries, and if they do so the protection will apply from the priority date onwards in the countries concerned. Alternatively, inventors can use the "PCT (Patent Cooperation Treaty) procedure", which has been in force since 1978 and is administered by the World Intellectual Property Organisation (WIPO). The main advantages of the PCT procedure are the possibility to delay as long as possible the national or regional procedures, the respective fees and translation

1 Certain jurisdictions provide extended terms for certain inventions (*e.g.* drugs) in order to compensate for the administrative delays in granting approval to market.

2 While most of the methodologies and patent indicators described apply to patents and utility models (or utility patents), we focus on the former as patents are a more standardised intellectual property right over inventions worldwide than the latter. Utility model or "petty patents", like patents, give market exclusivity to their holder. As compared with patents, they are weaker (shorter life span, often six or ten years) and easier to obtain (less stringent patentability requirements). They are not available in all countries.

costs, and the unified filing procedure (see Chapter 3).[3] It is now the most popular route among inventors targeting worldwide markets.

- ***Regional routes.*** Applicants can also submit a patent application to a regional office (*e.g.* Eurasian office, ARIPO, OAPI). For instance, the EPO (European Patent Office) is a regional office which searches and examines patent applications on behalf of European countries, with 32 members in 2007. EPO grants "European patents", which are valid in all its member states in which the holder has validated his rights. Validation requires translation into the national language and payment of national fees. In this national stage, European patents are submitted to national laws.

17. National patent laws have to comply with international standards, now laid down in the TRIPS (Trade-Related Aspects of Intellectual Property Rights), an international treaty which is part of the WTO (World Trade Organisation) package signed in 1994. Provided that a country is a member of the WTO, TRIPS imposes strict conditions on WTO members, such as patentability of inventions in all fields of technology, minimal duration of patents of 20 years, limitations of compulsory licensing, etc.

18. After being granted by an administrative authority, a patent can still be challenged by third parties. They can do so through the legal system, requesting that a patent be revoked or deemed invalid. In such cases, the patent holder also needs to go to court in order to enforce the disputed patent, alleging third-party *infringement*. This is, again, a purely national process, even in Europe.[4]

19. The procedure for obtaining a patent involves the disclosure of much information for legal or administrative purposes. This information is potentially of great interest to statisticians. The front page of a patent published by the WIPO, EPO, JPO and USPTO are shown in Figures 2.1 to 2.4. Useful information found in patent documents includes:

- Number and type of application, publication number, etc.[5]

- Name and address of the inventor; name and address of the applicant or assignee (usually the company employing the inventor).

- Technical details regarding the invention: title, abstract, detailed description of the invention, indicating how it is constructed, how it is used and what benefits it brings, compared with what already exists.

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3 This procedure allows temporary protection worldwide while keeping the right to file actual patent applications in member countries later. An international patent application has two phases. The first phase is the international phase in which patent protection is pending under a single patent application filed with the patent office of a contracting state of the PCT. The second phase is the national and regional phase, which follows the international phase in which rights are continued by filing necessary documents with the patent offices of separate PCT contracting states.

4 However, in Europe, the centralised EP opposition procedure as well as the centralised EP appeal procedure may lead to the revocation of a European patent as an alternative to legal action.

5 Following the World Intellectual Property Organization (WIPO) standards, two-letter INID codes ("internationally agreed numbers for the identification of bibliographic data") are indicated to identify bibliographic elements on the front page of a patent document. They help to harmonise the usage and appearance of patent specifications and related material, and provide a means of conveying information without using foreign languages or scripts.

- A list of claims, which is a clear and concise definition of what the patent legally protects.
- A series of codes corresponding to items in a technology classification.
- A series of dates: date of priority, application, grant, etc.
- A list of references to other patents or scientific literature considered as relevant to the determination of patentability of the invention.

2.4 Economic foundations of patents

20. The stated purpose of the patent system is to encourage invention and technical progress by providing a temporary period of exclusivity over the invention in exchange for its disclosure. By providing protection and exclusivity, a patent is a policy instrument intended to encourage inventors to invest in research and the subsequent innovative work that will put those inventions to practical use.

21. Patents reinforce inventiveness in different ways (Scotchmer 2004, Guellec and van Pottelsberghe 2007). Because patents reveal new knowledge through disclosure of inventions, they diffuse information that could otherwise be kept secret, enabling other inventors to develop new inventions. By diffusing information on what inventions have been achieved and are protected, the patent system also deters needless duplication of R&D efforts, encouraging researchers to focus on really new areas. In addition, as patents are legal titles, they can be traded. Patent rights thereby facilitate the development of technology markets, which improves the allocation of resources (for technology use) in the economy as patent rights allow the most efficient users to implement inventions although they did not necessarily invent them, or to exchange technologies necessary for further innovations.

22. The reason for providing a legal framework to protect inventions is that information is a public *non-excludable* and *non-rival* good. “Non-excludable” means that it is impossible to exclude others, who did not bear the cost of invention, from using the good (*i.e.* “free riding”). A “non-rival” good is one the consumption of which by one person does not reduce the quantity available to other individuals (*i.e.* the marginal cost is zero). Patent rights make the invention excludable, as the authorisation of the inventor is needed to use it, while keeping it non-rival, so many entities can use it at the same time.

23. However, information (knowledge) is not a perfect public good and it can be protected in other ways than patents, or in most cases, in complementarity to patents (Blind *et al.*, 2002). Other strategies to protect returns to inventions are secrecy,[6] rapid launching and short product development cycle times, low prices and other competitive approaches (production and marketing capabilities; after-sale service; long-term contracts). The use of these strategies has been confirmed by various business surveys (Levin *et al.*, 1987; Cohen *et al.*, 1994). For instance, in the Carnegie Mellon Survey (1994) on American firms, it was found that secrecy and lead time were ranked overall as the two most effective appropriability mechanisms for product innovations, with scores at just over 50% for each. Furthermore, companies declared that patent applications are only submitted for 52% of product inventions and 33% of process inventions. In the NISTEP Survey (Goto and Nagata, 1997) on Japanese firms, it was found that lead time (41%) was also ranked as the most effective appropriability mechanism for product innovations, and that complementary assets for manufacturing (33%) followed protection by patents (38%). In the EPO applicant panel survey of 2006, it was found that about 50% of inventions become patented, with the highest proportions found for audio, video, and media and electronics (about 70%). The lowest proportions were in biotechnology and pure and applied organic chemistry at about 25%.

[6] However, trade secrets are subject to legal protection in the framework of TRIPS (see art. 39).

24. Patents also have drawbacks. They encourage new inventions *ex-ante*, but have a cost *ex-post*: after the invention has been made its use is limited; it is controlled by the patent owner. By giving exclusivity of use to a particular company, a patent will limit competition and drive up prices, thereby excluding customers who would have been ready to pay the marginal cost of a good but cannot pay the mark-up charged by the patent owner. This is considered the central dilemma caused by patents; they improve dynamic efficiency of the economy (by fostering innovation, hence growth and value creation), but this is to the detriment of static efficiency (reduced competition and thus higher prices, which excludes some consumers).[7] Patent policy provides various tools to deal with this dilemma. In particular, both the duration of patent protection and the breadth (how different another product must be in order to not be an infringement), are instrumental in influencing the balance between protection and diffusion: longer and broader patents favour protection, while shorter and narrower ones favour diffusion.

25. The policy design is more difficult in the case of cumulative invention (or complementary, *i.e.* inventions building on each other). In this case, it is argued that patents can limit access to technologies which are necessary for further innovation, as follow-on inventors should not infringe patented knowledge although they need it for their own inventions. This configuration of cumulative inventions raises the policy issue of how to balance the protection given to the initial invention and the follow-on invention. This dilemma exists for instance in biotechnology, regarding particular treatments (patented) associated with certain genetic pathways (also patented). In case of new inventions relying on several inventions patented in the past, as happens for example in biotechnology and software, the new inventor needs to negotiate access to each of the existing inventions. In these cases, it has been argued that transactions can be so costly as to deter the new invention in the first place. There are some patent-based solutions to reduce transactional costs, such as patent pools (consortiums of companies agreeing to cross-license their patents and license them to third parties), and patent clearing house models which aim to standardise transactions (in terms of contracting clauses, royalty rates, etc.). However, in order to ensure conformity with patent rights and a well functioning market, patent policies must abide by competition policies and anti-trust laws.[8]

26. Because of these advantages and drawbacks in the use of patents as policy instruments, there has been on-going debate among economists about the best design for a patent system and whether it is in the interest of society to have such a system in the first place. No absolute consensus has emerged, but there is broad agreement on the following points:

- Patents granted should be of "high quality", meaning that they should cover significant inventions only, and reveal the actual content of the invention.
- Competition policy should keep close watch on the patent system.
- The patent system should be used as a complement to other instruments of innovation policy, notably science policy, sectoral policies and public procurement.
- Mechanisms that facilitate the circulation of and access to patents should be encouraged, although not at the detriment of competition (*e.g.* patent pools, licensing contracts etc.).

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7 The extent and duration of market power depends on several factors, *e.g.* the degree of substitution of technologies, the rate of technological change, etc.

8 Some practices in the exploitation of patents can restrict competition in technology markets beyond the rights embodied in the intellectual property right, *e.g.* tying the sale of other unpatented products or materials to patented inventions (tie-in), restraining licensees' commerce outside the scope of the patent (tie-out), imposing veto power over grants of further licenses, setting royalties not reasonably related to sales of the patented products, etc.

27. Since the early 1980s, the emergence of important market and policy changes has helped to expand the role of patents in the economy. With increased international competition, the emergence of information technologies and biotechnology, and the increased importance of start-ups and firms specialised in R&D, the use of patents has become more widespread among innovative firms. The growing relevance of technological competition in markets has increased the importance of intellectual property rights in companies' economic value. In parallel, since the early 1980s patent policy worldwide has been oriented toward strengthening the rights of patent holders. In the United States, the Federal Court Improvements Act, enacted in March 1982, created the Court of Appeals of the Federal Circuit (CAFC) to consolidate patent decisions (the CAFC was assigned jurisdiction over appeals of patent cases in all the federal circuits); and from 1980 the Bayh-Dole Act enabled non-profit research groups to patent and commercialise technologies developed with federal funds, in view of facilitating their commercialisation.

28. In Europe, the creation of the European Patent Office (established in 1977) resulted in stronger patents in many countries. In Japan, a series of reforms since the late 1990 has tended to re-inforce patent holders' rights. The signature of the TRIPS in 1994 marked the willingness of countries to push for improved harmonisation of patent rights across the world. As a result of these moves, the number of patent applications grew considerably worldwide between the mid-1990s and the mid-2000s and continues to rise. For instance, the number of patent applications at the EPO grew by 6% a year on average over the period 1995-2005, while at the USPTO applications rose by an average of 7% a year (OECD, 2007).[9]

29. The patent landscape changed markedly as a result, as new actors have emerged (universities), and non-standard uses of patents have expanded (*e.g.* licensing, raising capital). It is important to keep this changing context in mind when interpreting patent statistics, especially time trends and cross-country or cross-industry comparisons.

2.5 The information content of patent documents

30. A patent document contains a large amount of information, all of which has potential for statistical analysis. This is not only true for the bibliographic information gathered on the front page, but also even for the abstract, the claims, and the description of the invention, which can be subjected to textual analysis. For statistical purposes, information contained in a patent document can be grouped into three distinct categories:

- i) Technical description of the invention.
- ii) Development and ownership of the invention.
- iii) History of the application.

31. Most types of the information explained below are available regardless of the patent office where the application is filed, as information requirements and procedures are quite standardised across the world. Some of the procedural information is not available from patent documents themselves, but is still recorded and published by patent offices in other ways.

Technical description of the invention

- Title and abstract (describes the invention).

9 On the other hand, the number of patent applications at the JPO was relatively stable over the period 1991-2005 (OECD, 2007).

- The list of "claims". This describes the innovative content of the claimed field of exclusivity. The claims define the scope of protection of the patent rights (legal boundaries). It can be more or less broad or narrow, depending on the content and number of claims.

- The technical classes to which the invention pertains (based on patent classification). These are fixed by patent examiners. The most commonly used classification in use is the International Patent Classification (IPC) system. In parallel, national (*e.g.* USPC at the USPTO) or regional (ECLA at the EPO) patent classification is contained in a patent document (*e.g.* ECLA is very detailed with more than 100 000 categories; it is an elaboration of the IPC).

- Prior art.Each patent lists prior art relevant to the invention. The cited references (both patent and non-patent) help to define the patent's claims and its specific uses and applications.

- Patent references. These are citations to previous relevant technology protected by or described in other patents filed anywhere in the world, at any time, in any language.

- Non-patent references. These include scientific publications, conference proceedings, books, database guides, technical manuals, descriptions of standards, etc.

Development and ownership of the invention

- The list of inventors and their respective addresses. Inventors are individuals, usually employees of the patent applicants.

- The list of applicants (assignees in the United States) and their respective addresses. Applicants will have legal title to (be the owners of) the patent if it is granted. In the vast majority of cases, the applicants will be companies and the inventors their employees. However, it is also possible for the same person to be an inventor and an applicant (*e.g.* independent inventors).[10]

History of the application

- Publication number, application number, patent (grant) number. These numbers have various formats depending on the patent office. They can be used as identifiers when performing data analysis on patent databases.

- Priority number. This is the application or publication number of the priority application, if applicable. It allows to identify the priority country, reconstruct patent families, etc.

- Priority date. This is the first date of filing of a patent application, anywhere in the world (usually in the applicant's domestic patent office), to protect an invention. It is the closest to the date of invention.

- Date of filing. This is the first day that protection will apply in the country concerned if the patent is to be granted.

10 Changes in ownership over time are not always recorded in patent databases. In the majority of patent offices, the last information released reports the last owner(s) registered, and registration of a new owner, in the event of such a change, is not compulsory.

- Date of publication, Patents are normally published (*i.e.* the information is available to the public) 18 months after the priority date. Prior to the publication of a patent document, the content of the document remains secret.[11]

- List of designation. For patent applications filed using the European Patent Convention or Patent Cooperation Treaty procedures, applicants are required to designate the member countries where protection is being sought.

- Date of refusal or withdrawal. This indicates that the invention did not fulfil the statutory criteria (novelty, non-obviousness or industrial applicability) for patentability, or that the applicant decided to suspend the patent application during the examination process.

- Date of grant. There is a delay between the application date and the date of patent approval. In general, it takes between two and eight years for a patent to be granted.

- Date of lapse. A patent can lapse prior to the statutory expiry date if renewal fees are not paid or if it is revoked by courts. This "post-grant information" is usually available from "patent registers", which also record (depending on the country) changes in ownership, declared licensing contracts, etc.[12]

2.6 Patents as statistical indicators of inventive activity

32. Among the few available indicators of technology output, patent indicators are probably the most frequently used. Patent-based statistics have several uses. They allow to measure the inventiveness of countries, regions, firms, or individual inventors, under the assumptions that patents are a reflection of inventive output and that more patents mean more inventions. Empirical research has shown that patents are frequently a good predictor of economic performance. In a study of 258 R&D professionals, Keller and Holland (1982) concluded that an inventor's number of patents is significantly correlated with superior performance ratings and self-rating. In a study of 1 200 companies in high-tech industries, Hagedoorn and Clood (2003) concluded that the number of patents filed by a company is a very good reflection of its technological performance. At the country level, a high correlation between patent numbers and R&D performance has been found by de Rassenfosse and van Pottelsberghe (2008).

33. Patents statistics are also used to map certain aspects of the dynamics of the innovation process (*e.g.* co-operation in research, diffusion of technology across industries or countries, etc.), or of the competitive process (the market strategy of businesses); they are also used to monitor the patent system itself. Patents are also helpful for tracking globalisation patterns. For example, using the inventors' address, patent indicators can be developed to monitor the internationalisation of research, *i.e.* international co-invention in science and technology (S&T) activities or the mobility of inventors across countries.

34. Whereas patent applications are an indicator of successful research – notably in a particular line of research or programme – patents do not reflect all research or innovative efforts behind an invention.. On the other hand, an invention covered by a patent (a new product or process) needs not actually be industrially applied. It is reported that many patents are not implemented at all, as after submitting an application the inventor realises that the economic value of the invention is not sufficient, or that a superior invention can be marketed more rapidly. According to the PATVAL survey (2005), about 40% of patents

[11] In some cases, applicants can request early publication of the patent application prior to the habitual dates (see Chapter 3, Section 3.3.2).

[12] In certain offices, patent applications can also 'lapse' during examination, due to refusal or non-payment of fees, or "induced withdrawal" after a discouraging search report or for applicants' own business reasons.

in the sample are not used for industrial or commercial purposes due to strategic reasons or because the owners lack the complementary downstream assets to exploit them: 18.7% are not used and aim to block competitors, and 17.4% are considered as "sleeping patents" that are not used at all.

35. Patents can also be considered as an intermediate step between R&D (upstream) and innovation (which means that the invention is used in economic processes downstream). Patents can be obtained at different stages of the R&D process; this is notably the case in incremental or cumulative inventions. In this sense, patents can be seen not only as an output of R&D, but also as an input to innovation. In this regard, patents may be considered both as inputs and outputs in the invention process. This intermediate character makes patent data a useful bridge between R&D data and innovation data (both collected through business surveys).

36. Patent data have advantages and disadvantages in their ability to reflect inventive activities. Major advantages of patent data are:

- Patents cover a broad range of technologies on which there are sometimes few other sources of data (*i.e.* nanotechnology).

- Patents have a close (if not perfect) link to invention. Most significant inventions from businesses are patented, whether they are R&D-based or not.

- Each patent document contains detailed information on the invention process: a reasonably complete description of the invention, the technology field concerned, the inventors (name, address), the applicant (owner), the citations to previous patents and scientific articles to which this invention relates, etc. The amount of patent data available to researchers is huge. More than one million patents are applied for worldwide each year, providing unique information on the progress of invention. Patent data are public, unlike survey data which are usually protected by statistical secrecy laws.

- The coverage of patent data in terms of space and time is unique. Patent data are available from all countries with a patent system, *i.e.* nearly all countries in the world. Patent data are available--sometimes even in electronic form--from the birth of patent systems, which can go back to the 19th century in most OECD countries.

- Patent data are quite readily available (now electronically) from national and regional patent offices. The marginal cost for the statistician is much less than for conducting surveys although it is sometimes still significant (data need to be cleaned, formatted, etc.). Unlike survey data, collection of patent statistics does not put any supplementary burden on the reporting unit (*e.g.* business) because the data are already collected by patent offices to process applications.

37. However, as indicators of technological activity, patents have certain drawbacks:

- Not all inventions are patented. Inventions with few economic expectations might not justify the cost of patenting. Inventions with a trivial contribution to the art or non-technological inventions do not qualify under the legal requirements of patenting. Strategic considerations might lead the inventor to prefer alternative protection (secrecy). Hence patent data might not reflect such inventions (*e.g.* Pavitt, 1988).

- The propensity to file patent applications differs significantly across technical fields. For instance, in the electronics industry (*e.g.* semiconductors) each invention can be covered by several patents, with the aim to deter the entry of new competitors and to negotiate advantageous cross-licensing deals with competitors. This "patent flooding" strategy obviously results in an increasing number of patents relative to the number of inventions. Conversely, the pharmaceutical industry is characterised by smaller numbers of high-value patents – it has the highest level of R&D expenditure per patent. It is therefore not straightforward to compare patent numbers across technical fields. The propensity to patent also differs between companies. New or small and medium-sized enterprises (SMEs) --notably those without large-scale production-- have greater difficulty covering the costs of a patent (although national policies attempt to deal with this problem by providing subsidies or discount rates for SMEs to patent).

- The value distribution of patents is highly skewed. Many patents have no industrial application (hence, are of little or no value to society), whereas a few are of very high value. With such heterogeneity, simple patent counts could be misleading. This is not specific to patents, as it is a reflection of a major feature of the inventive process which can also apply to R&D expenditure (much of it resulting in little, whereas some achieves great success).

- Differences in patent law and practice around the world limit the comparability of patent statistics across countries. It is therefore preferable to use homogenous patent data (coming from a single patent office or single set of patent offices).

- Changes in patent laws over the years call for caution when analysing trends over time. The protection afforded to patentees worldwide has been stepped up since the early 1980s, and as a result companies are more inclined to patent than before. The list of technologies covered has grown longer over time and in some countries now includes software and genetic sequences, which had been excluded before. Other variables such as office administration can have a substantial impact on patent counts, notably granted patents, during a particular time period.

- Patent data are complex, as they are generated by complex legal and economic processes. It is therefore important to take into account all of these factors when compiling and interpreting patent data, as failing to do so leads to erroneous conclusions.

38. Most of the limitations outlined above can be overcome by addressing data biases and limitations through appropriate methodologies to limit their impact . For example, the issue of the skewed distribution of patent value can be addressed by weighting patent counts by number of citations, or selecting a sub-sample of patents that are of similar value (*e.g.* triadic patents capture high-value patents, see Chapter 4). Similarly, to surmount the drawbacks associated with differing propensities to patent across industries, one can restrict the analysis to a sector or industry, or weigh the data appropriately.

39. Depending on the question, patent data can be used in conjunction with other data, such as R&D or innovation survey data to investigate innovation and technological performance. This combination allows to corroborate (or negate) interpretations drawn from of each separate source of data, and data linking allows for more information to be extracted (*e.g.* the degree of success of R&D can be inferred from patent filings in certain circumstances). Certain researchers have linked patent data with other data, such as R&D surveys or other business data (notably private databases); others have developed special surveys which complement patent data and allow to better measure the variables of interest, *e.g.* surveys of technology companies about their use of patents (the Carnegie Mellon survey, Cohen *et al*., 1994), surveys of inventors about the process having led up to the patent or about the value of patents (Gambardella *et al*., 2006).

2.7 Patent databases

40. Patent databases have been developed for a long time. Databases including the bibliographic (as described in Section 2.3.) and full text of patents are basic tools in the research and examination procedures carried out at patent offices, as they record the patented prior art. In the last decade, there have been expansions and patent data have been linked to other information: company data (*e.g.* after standardisation of applicants' names and matching to companies' lists of names), industry classifications, codification of territorial levels (regions) based on information of addresses (inventors or applicants), etc.

41. Patent databases can include additional information on the examination processes, such as the legal status of examination, as well as filing and application publication. Some other types of data are rarely codified by patent data producers. For instance, changes in the ownership during the examination process or through the life of a patent are seldom registered in the traditional patent databases that are made available by patent offices.

42. Although patent data are produced by the patent authorities, patent databases using such data are also produced and published by private entities. Users should be attentive to the types of patent information contained in the databases and the kinds of information that can be reflected in the statistics and indicators.

43. Some patent databases widely used for statistical and research purposes are: the NBER Patent Citations Data Files created by Jaffe, Trajtenberg, and Hall with from the assistance of researchers at the NBER and Case Western Reserve University; the EPO Worldwide Patent Statistical Database (also known as EPO PATSTAT) created by the EPO with the OECD Patent Statistics Task Force; and the IIP (Institute of Intellectual Property) patent database, which gathers internal patent data from JPO (Seiri Hyojunka Data).

2.8 Topics of investigation

44. Indicators and studies based on patent data are extremely diverse in terms of the format of the publication (statistical directories, policy report, academic research); the level of aggregation of the data compiled (national, regional, company level, industry or technical field level); of the approach taken (compilation of indicators, performance of econometric estimates); and of the analytical or policy questions addressed. Below is a non-exhaustive list of topics addressed in the flourishing literature using patent data.

- **Technological performance**. Patents are used to monitor the technological performance of companies (or other organisations), regions or countries. Compared to other output indicators such as publications, patents are a more proper indicator of activities closer to technology development. They help track technological leadership or positioning in a given technology field or area (*e.g.* revealed technological advantages indexes) and changes over time. As indicators of technological performance, the level of technological specialisation and/or strength of a geographical region or country (or company) helps policymakers identify weak and strong areas in national or regional innovation systems.

- **Emerging technologies**. Patent-based indicators are a unique means-- sometimes the only one available-- to track the rise of emerging technologies (*e.g.* nanotechnology, biotechnology). Particular technical fields can be reconstructed using keywords, or searching in the abstracts and patent descriptions. The detailed information provided in patent documents allows to identify the companies or agencies active in these fields, the modes of invention (*e.g.* inter-institutional collaboration), the mapping of technology clusters, etc. Patent data can be used in conjunction with scientific publications data. Business surveys usually come at a later stage of development, as they require precise advance knowledge of the field (notably of the active entities).

- **Knowledge diffusion and the dynamics of technical change.** Because they provide a detailed description of how the inventions have been made and the prior art, patents are a reliable measure of knowledge transfer. Patent citations allow to track the use of inventions in further inventions. It is therefore possible to identify the influence of particular inventions or particular sets of inventions and map their diffusion in the economy. Citations of other patents or the non-patent literature (notably scientific publications) are useful in quantifying knowledge transfer across organisations (*e.g.* company to company or university to industry), geographical regions and/or technology fields, and knowledge spillovers from specific inventing entities (*e.g.* multinational to domestic firms or from public research centres to industry).

- **Geography of invention.** As the addresses of the inventor and applicant are reported, patents can be allocated across regions in any degree of detail (although this involves a non-negligible amount of work as the raw data are not always well formatted). Hence patent data can be used to study the geographical properties of the inventive processes, *e.g.* the role of local actors in regional or national innovation (universities, small companies, large companies, etc.), their interactions, the profile and impact of regional technological specialisation, etc.[13]

- **Creativity and social networks.** Patent information can be used to track the career path and performance of individual inventors (*e.g.* their field of work, location, employer), or for analysis of networks of inventors (who invents with whom, etc.).

- **The economic value of inventions.** The value of inventions is an important component of their economic impact. Patent data provide unique access to information about the value of inventions. Correlations have been proved between the value of a patent and the number and quality of its (forward) citations; this information can be exploited to compile indicators of relative value of patents. Through matching applicants' names with company data, patent data can be linked to economic data such as stock market data, accounting data, etc.

- **Performance and mobility of researchers.** As the inventor's name is reported in patent documents, it is possible to investigate aspects of inventiveness at the level of individual researchers. This involves a great deal of data cleaning, as identifying individuals in databases with millions of names is not a straightforward task. This information can be used to investigate issues such as researcher mobility (across companies or countries), profile differences across fields, who works with whom, gender issues (when identifiable with the aid of complementary data), etc. (Trajtenberg *et al.*, 2006).

- **The role of universities in technological development.** The impact of universities can be observed through the patents they have taken and compiling counts of such patents and their (forward) citations, etc. It can also be observed through citations received by academic research in patents filed by industry (Narin *et al.,* 1999). In an increasing number of countries the number of patents is used by funding agencies or ministries to evaluate the performance of academic institutions or individual researchers.

[13] Attention must be paid when interpreting geographical patent data, notably in terms of activities by companies, as their research activity is spread geographically and the address of invention might not necessarily be where the research took place.

- **Globalisation of R&D activities.** Patents include information on the inventive performance and activities of multinational firms. Through the applicants' and inventors'addresses, it is possible to track patterns and the intensity of international co-invention (the measure of research collaboration between inventors located in different countries), foreign ownership of domestic inventions and vice versa..

- **Patenting strategies by companies.** The history of the patent application is also available in a patent document. This reveals the timeline of the invention, the application's passage through the patent office's workflow, and the applicant's strategies (designated states, patent equivalents and priority dates, etc). This information is helpful in identifying the market strategy of the patent owner, notably geographical destinations in which protection is being sought and their order of importance.

- **Assessing the effectiveness of the patent system.** Patent data can also be used by assessing the effect of the patent system on inventions and diffusion. To what extent and in which ways does the economy benefit from the patent system? To what extent are certain strategies with alleged negative social impact (blocking, fencing, etc.) adopted by applicants? What is the effect of particular patent-related policies on national economic performance?

- **Forecasting patent applications.** Patent data compiled over time are also helpful in predicting future demand for patents, which is useful for patent offices' budgetary planning.

- **Monitoring the internal working of the patent system.** Not surprisingly, patent data can also be used to monitor the patent system itself, *i.e.* the volume of patenting activity by companies, the way patent offices operate, etc. However, this use of patent data is not a major focus of this manual, which addresses patent data as indicators of technology. In many cases, different statistical rules should apply when monitoring the patent system. For instance, dates that are purely administrative (*e.g.* issue date of the search report), which are of little interest from an economic perspective, can be extremely important in assessing the internal performance of a patent office. Such use of patent data is mainly made by patent offices themselves (see the yearly trilateral statistical report jointly published by the EPO, JPO and USPTO, or the various statistical publications of the WIPO).

Figure 2.1 Front page of an EPO patent application

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 046 310 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **81106947.1**

(22) Date of filing: **18.10.79**

(51) Int. Cl.³: **H 02 K 15/02**, H 01 F 29/10, H 01 F 41/02

(30) Priority: **18.10.78 AU 6456/78**

(43) Date of publication of application: **24.02.82 Bulletin 82/8**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LU NL SE**

(60) Publication number of the earlier application in accordance with Art. 76 EPC: **0010685**

(71) Applicant: **Card-O-Matic Pty. Ltd., 20 McEvoy Street, Waterloo New South Wales, 2017 (AU)**

(72) Inventor: **Stanley, Louis, 22 Ponyara Road, Beverley Hills New South Wales 2209 (AU)**

(74) Representative: **Baillie, Iain Cameron et al, c/o Ladas & Parry Isartorplatz 5, D-8000 München 2 (DE)**

(54) **Electrical equipment and its fabrication.**

(57) An inductive electric machine such as an induction motor or a transformer having field and rotor cores, or, respectively, primary and secondary cores, each such core being formed of metal strip (204) punched to have a plurality of holes spaced and located at predetermined positions along the strip (204) so that, when the strip is wound about a central axis, the holes (205, 208, 209) are located so as to form radially extending slots (205, 208, 209) on a face of each such core. Windings (213) can be placed in the slots of the field core and in the slots of transformer cores. A conductor (208) can be placed in the slots of the rotor core.

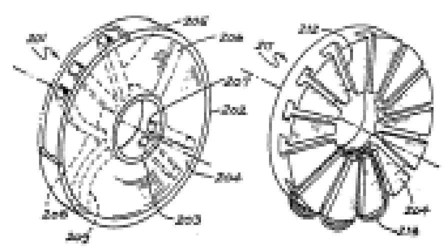


Figure 2.2. Sample front page of a JPO patent application

(This is just a sample, not a copy of a real application)

(19)日本国特許庁(JP)　　(12)公 開 特 許 公 報(A)　　(11)特許出願公開番号
特開２０００－２４４５７９
（Ｐ２０００－２４４５７９Ａ）
(43)公開日　平成12年５月20日(2000.5.20)

(51)Int.Cl.⁷		識別記号	FI				テーマコード(参考)
ＧＯ１Ｂ	3/00	１０１	ＧＯ１Ｂ	3/00	101	A	2C032
ＧＯ２Ｃ	26/00		ＧＯ２Ｃ	26/00			2F029
	23/02			23/02			
			Ａ４５Ｃ	12/00	101	A	
			Ａ４７Ｂ	23/02			

審査請求　未請求　請求項の数１　ＯＬ　外国語出願　公開請求　（全６頁）　最終頁に続く

(21)出願番号　特願平11-123456

(22)出願日　平成11年11月10日(1999.11.10)

(31)優先権主張番号　８３３０４３５９．９
(32)優先日　平成10年11月12日(1998.11.12)
(33)優先権主張国　フランス（ＦＲ）

特許法第30条第１項適用申請有り　平成10年９月21日付画像工学会研究専門委員会主催の1992年度画像符号化シンポジウム（ＰＳＣＪ92）において文書をもって発表

特許法第65条の２第２項第４号の規定により明細書及び図面の一部は不掲載とする。

(71)出願人　390000011
パテント　コーポレーション
Ｐａｔｅｎｔ　Ｃｏｏｐｏｒａｔｉｏｎ
アメリカ合衆国ケンタッキールイビル
ピー・オー・ボックス 35090　ルイビルガレリアブラウン　タワー 1500　（無番地）
(71)出願人　090000423
日本特許発明株式会社
東京都千代田区内幸町４丁目５番６号
(72)発明者　発明　太郎
神奈川県横須賀市壱１丁目2200番地
(74)代理人　123456789
弁理士　代理　太郎　（外２名）
最終頁に続く

(54)【発明の名称】ファクシミリ走査装置

(57)【要約】　（修正有）
【目的】ファクシミリ端末パラメータ識別方法に関し、ファクシミリ装置機能のパラメータ拡張を容易にする。
【構成】通信時の端末パラメータを識別する方法において、端末パラメータを含む制御信号の送信端末１ａ、１ｂは制御信号のファクシミリ情報フィールドを、複数のサブフィールドに分離し、各サブフィールドの情報を分離するファクシミリ情報フィールドのデータ中には現れない特定の識別コードを挿入してファクシミリ情報フィールドを作成する。制御信号の受信端末７はファクシミリ情報フィールド内の上記特定の識別コードを検出し、ファクシミリ情報フィールドを複数のサブフィールドに分離して、各サブフィールドの情報の内容を解析し相手端末の端末パラメータの内容を検出する。装置機能のパラメータを拡張する場合はユニークコードを挿入して可変長の端末パラメータを分離する。

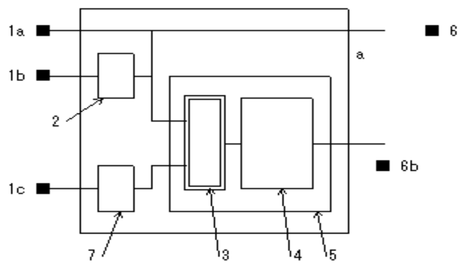


Figure 2.3. Front page of a USPTO patent

US 20080045039A1

(19) **United States**
(12) **Patent Application Publication** (10) **Pub. No.: US 2008/0045039 A1**
Conti et al. (43) **Pub. Date: Feb. 21, 2008**

(54) **METHOD OF FORMING NITRIDE FILMS WITH HIGH COMPRESSIVE STRESS FOR IMPROVED PFET DEVICE PERFORMANCE**

(75) Inventors: **Richard A. Conti**, Katonah, NY (US); **Ronald P. Bourque**, Wappingers Falls, NY (US); **Nancy R. Klymko**, Hopewell Junction, NY (US); **Anita Madan**, Danbury, NY (US); **Michael C. Smits**, Poughkeepsie, NY (US); **Roy H. Tilghman**, Stormville, NY (US); **Kwong Hon Wong**, Wappingers Falls, NY (US); **Daewon Yang**, Hopewell Junction, NY (US)

Correspondence Address:
INTERNATIONAL BUSINESS MACHINES CORPORATION
DEPT. 18G
BLDG. 300-482
2070 ROUTE 52
HOPEWELL JUNCTION, NY 12533 (US)

(73) Assignees: **INTERNATIONAL BUSINESS MACHINES CORPORATION**, Armonk, NY (US); **NOVELLUS SYSTEMS, INC.**, San Jose, CA (US)

(21) Appl. No.: **11/873,721**

(22) Filed: **Oct. 17, 2007**

Related U.S. Application Data

(62) Division of application No. 11/160,705, filed on Jul. 6, 2005.

Publication Classification

(51) **Int. Cl.**
H01L 21/31 (2006.01)
(52) **U.S. Cl.** **438/792**; 257/E21

(57) **ABSTRACT**

A method is provided for making a FET device in which a nitride layer overlies the PFET gate structure, where the nitride layer has a compressive stress with a magnitude greater than about 2.8 GPa. This compressive stress permits improved device performance in the PFET. The nitride layer is deposited using a high-density plasma (HDP) process, wherein the substrate is disposed on an electrode to which a bias power in the range of about 50 W to about 500 W is supplied. The bias power is characterized as high-frequency power (supplied by an RF generator at 13.56 MHz). The FET device may also include NFET gate structures. A blocking layer is deposited over the NFET gate structures so that the nitride layer overlies the blocking layer; after the blocking layer is removed, the nitride layer is not in contact with the NFET gate structures. The nitride layer has a thickness in the range of about 300-2000 A.

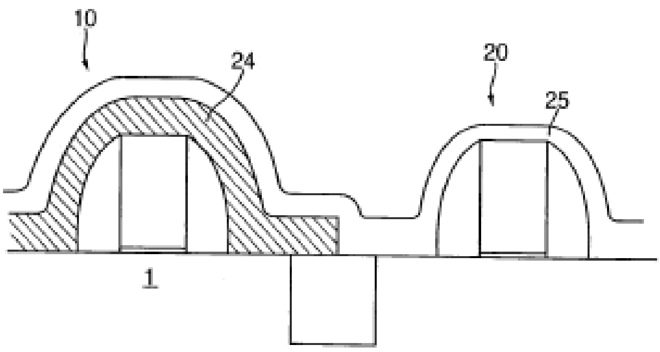


Figure 2.4. Front page of a PCT application

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 December 2003 (18.12.2003)

PCT

(10) International Publication Number
WO 03/104470 A2

(51) International Patent Classification[7]: **C12N 15/90**, 9/12, 15/11, 15/79, A61K 48/00

(21) International Application Number: PCT/CA03/00850

(22) International Filing Date: 5 June 2003 (05.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/386,640 5 June 2002 (05.06.2002) US

(71) Applicant *(for all designated States except US)*: **HER MAJESTY IN RIGHT OF CANADA As represented By the MINISTER OF AGRICULTURE AND AGRI-FOOD CANADA** [CA/CA]; Agriculture and Agri-food Canada, Saskatchewan Research Centre, 107 Science Place, Saskatoon, Saskatchewan S7N 0X2 (CA).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **ROZWADOWSKI, Kevin, L.** [CA/CA]; 86 Harvard Crescent, Saskatoon, Saskatchewan S7N 3R1 (CA). **LYDIATE, Derek, J.** [GB/CA]; 101 Albert Street, Saskatoon, Saskatchewan S7N 1E6 (CA).

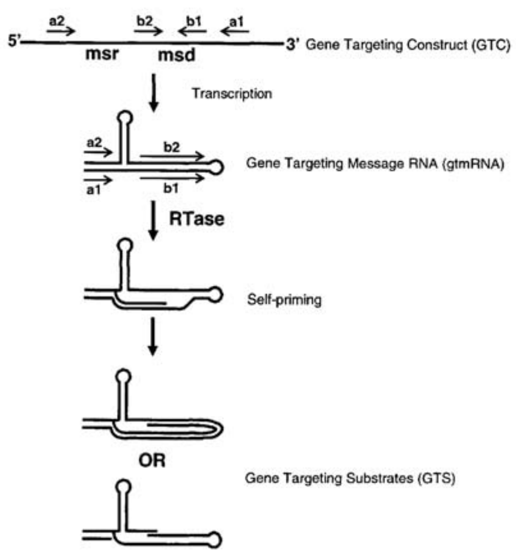
(74) Agents: Kingwell, Brian, G. et al.; Smart and Biggar Box 11560, Vancouve 650 West Georgia Street, Suite 2200 Vancouver, British Columbia V6B 4N8 (CA).

(81) Designated States *(national)*: AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,

[Continued on next page]

(54) Title: RETRONS FOR GENE TARGETING



(57) Abstract: The invention provides methods and nucleic acid constructs that may be used to modify a nucleic acid of interest at a target locus within the genome of a host. In some aspects, the invention contemplates producing *in vivo* a gene targeting substrate (GTS), which may be comprised of both DNA and RNA components. The gene targeting substrate may comprise a gene targetig nucleotide sequence (GTNS), which is homologous to the target locus, but comprises a sequence modification compared to the target locus. The gene targeting substrate may be produced by reverse transcription of a gene targeting message RNA (gtmRNA). The gene targeting message RNA may be folded for self-priming for reverse transcription by a reverse transcriptase. The gene targeting message RNA may in turn be the product of transcription of a gene targeting construct (GTC) encoding the gene targeting message RNA. The gene targeting construct may for example be a DNA sequence integrated into the genome of the host, or integrated into an extrachromosomal element. Following expression of the gene targeting systems of the invention, hosts may for example be selected having genomic modifications at a target locus that correspond to the sequence modification present on the gene targeting nucleotide sequence. In some embodiments, the structure of retrons may be adapted for use in the gene targeting systems of the invention.

WO 03/104470 A2

CHAPTER 3

PATENT SYSTEMS AND PROCEDURES

3.1 Introduction

45. To obtain a patent for an invention, the individual or institution which owns the invention (an enterprise, or a public or private institution such as a university or a government body) has to file an application at the patent office. An applicant who wants to have patent protection in multiple countries can file for a patent in each country separately, file a patent application at a regional office, or file a patent application at the international patent office and request entry into the national stage in each country in which patent protection is sought.

46. The application and the processing of patents follow strict administrative and legal rules and procedures, set out in international treaties and national statutes (law and regulation). These procedures and rules have a direct impact on the value and the meaning of patent data. It is necessary to take them into account when interpreting patent statistics. This is all the more important as these rules are not totally harmonised across countries and have changed over time, and minor variations in the procedure can have drastic effects on the resulting numbers.

47. This chapter presents a summary of patenting procedures at the most important patent offices and patenting routes (EPO, JPO, USPTO and PCT). It starts with the standard rules common to all patent offices; it then investigates national and regional variations. It finally looks at the procedures for international applications.

48. The procedure for granting patents, the requirements placed on the patentee and sometimes the extent of exclusive rights vary widely between countries according to national laws and international agreements. As we will see, all patent applications, whether international or regional, should ultimately have a national status as they need to be validated by national patent offices. In consequence, national specificities, both regarding the patenting process and post-grant activity (*e.g.* maintenance, enforcement, and invalidation procedures) determine the way patents function in economic life. These aspects need to be taken into account when choosing particular patent data, and computing and interpreting patent indicators.

3.2 The core patenting procedure

49. The procedure for getting a patent involves several steps which are similar in all countries:

- *First*, the entity (usually a company, but it can be an individual, a university or a governmental body) seeking patent protection must file a patent application at a patent office. In the application, the applicant must disclose the invention in sufficient detail for the average skilled person to be able to understand and implement it. The most important part of the application is the section on claims, a list of aspects of the invention for which the applicant is claiming exclusive rights. The applicant must pay certain administrative fees, which are extremely variable across patent offices. [14]

- *Second*, the patent office appoints an examiner (or a group of examiners, with one leader) who will take charge of the application and who is assumed to be expert in the particular technical field. Usually the examiner first performs a novelty search, which involves checking the prior art documents deemed relevant to the particular invention. These documents include the precedents in the scientific and technical literature relevant to the invention (or part of it) and constitute the prior art against which the novelty of the invention will be compared. In general, only documents that were published before the date of filing of the application (or day of filing of the priority application, if there is one) are to be considered in the search. The patent application document, along with the search report, are made public 18 months after the filing date (with an exception in certain applications to the USPTO).[15]

- *Third*, the examiner (usually but not necessarily the same as in step two) studies the patent application in order to decide whether the invention is "non-obvious" and involves an "inventive step" relative to the prior art identified in the earlier search. The applicant has the right to submit a written opinion (to discuss the examiner's findings and interpretation of the literature found), and to modify the scope of the claims defined in the application if necessary. The grant means that no reasons for refusal are found as all the criteria for patentability are covered: patentable *subject matter*, *novelty, inventive step (non-obviousness to a person skilled in the art) and industrial applicability* (see Box 3.1.).

- *Fourth*, when granted, a patent can be maintained for a maximum duration of 20 years from the filing date.[16] The patent holder is required to pay renewal fees (annual in most countries) to the patent office to maintain the patent. The patent office will revoke patents that are not renewed. A patent can be challenged, usually by competitors who think that the patent is not valid and that it should not have been granted as the patent office missed a significant weakness in the patent filing or did not correctly implement the statute. A patent can be challenged in the patent office itself in certain jurisdictions (*e.g.* opposition at the EPO; boards of appeal in the USPTO; invalidation procedure trial system at the JPO in Japan), and in courts. Courts have the last say in the enforcement of the patent statute.

Patents filed at a national (or regional) office provide protection only within that jurisdiction. For example, a patent granted by the USPTO will only provide patent rights within the United States. If the inventor (applicant) wishes to protect the same invention in Japan, then a separate patent application has to be filed at the JPO, either directly or via the Patent Cooperation Treaty (PCT) at the World Intellectual Property Organization (WIPO). Filing at WIPO does not prevent the applicant from filing at national offices.

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[14] In general, there is a waiting period between the request for examination and the first office action such as first notice of refusal or decision to grant. At the JPO, the average waiting period was 25.7 months in 2005.

[15] No search report is made available in USPTO pre-grant publications or in JPO patent applications.

[16] Many jurisdictions provide extended terms for drugs in order to compensate for the administrative delays in granting approval to market.

50. The decision of which country (or countries) to apply for patent protection in is firstly dependent on the applicant's business strategy. In most cases, a patent application is filed at the national patent office of the inventor (applicant) to protect the invention in the domestic market, followed by foreign filings. However, it is not mandatory to file the first application at the national patent office of the applicant. An applicant can file a patent application at any patent office in the world, without first filing an application at the national patent office. In the United States, however, a foreign filing license may be required before filing in a foreign country.

51. The country in which the first application is filed is referred to as the "*priority country*" and the date of first application is commonly referred to as the "*priority date*". Patent applications filed at a patent office by residents of that country are referred to as *domestic applications* (for statistical purposes) and applications by non-residents are referred to as *foreign applications*.

3.2.1 International harmonisation of patent laws

52. Various international treaties have been established over the years in order to streamline the application process and make patenting procedures more efficient for inventors (or applicants) targeting multiple countries. These application and examination procedures are governed by rules and regulations of the national (or regional) patent office, and international treaties (such as the Paris Convention and the Patent Cooperation Treaty) where applicable.

53. A considerable amount of harmonisation of patent rules across countries took place during the 1990s, notably through the creation of the Trade-related aspects of intellectual property rights (TRIPS) Agreement at the World Trade Organization (WTO) (see Box 3.2). The TRIPS Agreement is an international treaty administered by the WTO which sets down minimum standards for most forms of intellectual property regulation within all member countries of the WTO. It was negotiated at the end of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) treaty in 1994. It incorporates and builds upon the latest versions of the primary international intellectual property agreements administered by the World Intellectual Property Organization (WIPO), the Paris Convention for the Protection of Industrial Property, and the Berne Convention for the Protection of Literary and Artistic Works, agreements that go back to the 1880s. It applies basic international trade principles to member states regarding intellectual property, including national treatment and most-favoured-nation treatment. Major changes introduced by TRIPS include: the statutory duration of patents should be at least 20 years after application; patents should cover all fields of technology (including drugs, previously excluded in a number of countries); patents should be published 18 months after priority. Further negotiations have taken place in the 2000s at WIPO and between developed countries in order to further harmonise patent statutes and procedures across countries, but this has proven difficult to achieve.

3.2.2 The costs of filing patents and duration of procedures

54. Filing a patent is a costly matter for the applicant. The cost of patenting can be broken down into four main categories associated with the granting process and the maintenance of protection:

- **Administrative fees**: filing fees, search, examination, country designation, grant/publication fees and validation fees (in Europe).
- **Process costs**: costs associated with the drafting of the application and with the monitoring of the procedure (interaction with examiners and the patent office) on the applicant's side. These costs can be incurred in-house (corporate IP department) or externalised (private patent attorneys).
- **Translation costs** in the case of applications abroad. Such costs mainly arise once a patent is granted, and depends on the page length of the patent. The more countries are covered, the higher the translation costs.

- **Maintenance costs** are renewal fees to keep the patent valid during a maximum period of 20 years, plus possible fees to be paid to the patent agents serving as intermediaries between the patent holder and the patent office.[17] Renewal fees vary significantly across countries.

55. There are also the costs of enforcement, *i.e.* defending patent rights by identifying and fighting infringement (*e.g.* through lawsuits) or invalidation or opposition by other parties, etc. Calculating patent costs is a complex task, as several components are not easy to quantify and depend on the applicant's motivations for filing a patent. Several factors determine the total cost of a patent (*e.g.* the number of claims, the number of pages, the route, the quality of external services, the desired speed and the geographical scope for protection). Larger patents (*i.e.* with more claims and/or pages) and patents that are intended to be filed in a large number of EPC member states are more expensive in terms of both procedural and external cost. The cost is further linked to the duration of the procedure (especially when there is a great deal of written communication between the patent attorney and the patent office) as well as the desired speed of the granting process. In view of the high variability of cost across technical fields and countries, it is difficult to give meaningful average figures on the cost of filing patents. In addition, such costs should be related to the size of the market covered (*i.e.* the potential market on which exclusivity is sought for the invention).

56. A survey of patent applicants conducted in 2004 investigated the cost of patents (EPO, Roland Berger 2005). The cost of obtaining a standard Euro-direct patent (direct filing to the EPO or extension of an earlier national patent application) in 2003 was estimated at EUR 30 530 (EPO and Roland Berger Market Research) while the (estimated) costs of a Euro-PCT (filing through PCT at the WIPO designating EPO) averaged around EUR 46 700.[18] The difference with Euro-direct patent applications comes mainly from higher translation costs due to a larger number of pages (description and claims), supplementary official fees related to the international phase, and validation in a larger number of countries (eight instead of six). A company from a European country (EPO member state) will pay on average EUR 24 100 to have a Euro-direct patent granted and validated; a US company will pay EUR 10 250 to receive a USPTO grant; a Japanese company will pay EUR 5 460 to acquire a JPO grant. Higher cost in Europe is basically due to translation costs at the processing and validation stages. Although they vary across patent offices, official fees play a minor role in the total difference: applicants' reported figures are EUR 3 470 at the EPO, EUR 2 050 at the USPTO and EUR 1 570 at the JPO.

57. The duration of the procedures is also highly variable across patent offices and has changed over time. The average pendency time for examination (time between filing and a grant) at the EPO was about 40.6 months in 2005 but has been decreasing (1.9% with respect to 2004). In the JPO, pendency time was about 31.8 months in 2005 while in the USPTO, it took on average 30.6 months to either abandon or issue an application in 2005 (Trilateral Statistical Report, 2005).

58. All stages of the patenting procedure generate large amounts of information about the invention for which protection is sought. Information regarding the procedural stage of patent applications provides insight about the applicant's strategy, but also generates statistical difficulties.

17 Fees are due each year at the national patent offices of the EPC member countries or after three, seven and eleven years at the USPTO. Fees generally increase progressively over time. Once a patent is granted by the EPO, it must be validated in each desired national patent office of the EPC member countries. At the JPO, renewal fees are due as a lump-sum fee for the first three years and then annually from the fourth year of the date of grant.

18 This amount comprises the fees for the EPO grant procedure, the costs of representation by a patent attorney before the EPO, the translation and validation costs, and the renewal fees for maintenance of the patent.

- Firstly, no statistics are available until 18 months after the priority date as the application is not published until then[19]. This creates an obstacle for analysts as it limits the legally possible timeliness of patent data.

- The search report includes valuable information such as the references to prior art (patent and non-patent references), which can be viewed as the precedents to the invention covered by the patent.

- The list of countries where the application is filed, or the international route it takes (PCT) is an indication of the applicant's market strategy (local, regional or worldwide). It is also indicative of the invention's value, as one would expect the expected revenue from the patented invention to exceed the prospective cost of patenting for a patent to be filed in the first place.

- The length of the patenting procedure (the time it takes for the patent office to reach a decision) is indicative both of the strategy of the applicant (who can seek a quick grant or aim to lengthen the procedure) and the efficiency of the patent office (ability to manage its workload). The fact that an application is granted or refused is indicative of its quality.

3.3 National and regional procedures

59. All patent offices have their particular statute, and there are variations from the "core" presented above. Differences can be in "substantive patent law" (what is patentable or not, etc.) or in the procedures themselves, although the distinction between these two aspects is not always clear-cut. The most specific procedures are to be found at the EPO, as it is not a national but a regional, international patent office. Table 3.1 summarises some of the major differences in the rules applied by the three major offices. Active negotiations at international level are aiming to remove such differences in the future. Figure 3.1 outlines the main stages of the patent procedures in the EPO, JPO and USPTO.

60. The grant procedures are not identical across these patent offices. For instance, the examination at the EPO is done in two phases (search and substantive examination[20]) whereas in the national procedures before the JPO or the USPTO, both steps are undertaken in one phase. After examination, the patent office informs the applicant of its decision (EPO: announcement of a grant; JPO: the decision to grant; USPTO: notice of allowance). If a patent cannot be granted in the form as it was filed, the intention to reject the application is communicated (EPO: examination report; JPO: notification of reason for refusal; USPTO: office action of rejection). The applicant may then make amendments to the application, notably in the claims, after which examination is resumed. This procedural step lasts as long as the applicant continues to make appropriate amendments. Then, either the patent is granted or the application is finally rejected or withdrawn by the applicant. In all three patent offices, an applicant may withdraw or abandon the application at any time before the application is granted or finally rejected.

In the following section, we describe in more detail some of the differences between patent offices that need to be taken into account when computing patent statistics.

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19 Patent offices publish aggregate counts of recent applications for the purpose of monitoring their own activity, but these data are not accessible to outside users and cannot be exploited for analytical purposes.

20 Firstly, a search is done in order to establish the state of the art with respect to the invention. The applicant receives a search report accompanied by an initial opinion on patentability. In a second phase, the inventive step and industrial applicability are considered in the substantive examination.

3.3.1 USPTO

61. In the United States, the Constitution empowers Congress to make laws to "promote the progress of science and useful arts...". The laws Congress passed regarding the patent system were codified in Title 35 of the United States Code and created the United States Patent and Trademark Office.

62. The USPTO displays the following differences with the standard patent procedure and characteristics unique to their patent system, amongst them:

- The US grants a patent to the *"first to invent",* instead of the "first to file" in all other countries. It means that the first to file can see that right contested in front of the USPTO by another party claiming to have made the invention earlier although with no patent filing (a later patent filing).

- The US has the so-called "*grace period*" for assessing novelty. Publications (*e.g.* academic journals) by the inventor during the grace period, which can range to up to one year before the filing, are not regarded when determining the novelty of the invention.

- The statutory duration of patents has been 20 years from application since 1995 (when the US put the TRIPS into its national law), but it was 17 years after grant previously.[21] Renewal fees have to be paid 3.5, 7 and 11.5 years after grant (they are annual in most other countries).

- An application to the USPTO is automatically regarded as a request for examination (contrary to most other countries, where the applicant has a certain period after reception of the search report before deciding whether to file an examination request or not; *e.g.* EP procedure). It means notably that applicants will have to proceed to examination even if they realise after the search that the novelty of their invention is not certain. However, a growing number of applications to the USPTO are taking the PCT route, along which this rule does not apply.

- Until recently, US patents were only published after grant. This has been changed, and now in the US patent applications are published 18 months after their filing date, unless they have been withdrawn or they are filed with a non-publication request (if the applicant declares not to file a related application (in another country) that quotes the priority of the USPTO first filing).

- When submitting a patent application, applicants (or inventors) are requested to supply a list of the state of the art. Contrarily to patenting procedure at the EPO, there is a "duty of candour" on everyone involved in a US patent application from the inventor to the patent attorney to bring to the attention of the US Patent Office any prior art of which the inventor (as well as others involved in the filing of the patent application, such as the patent attorney) is aware or becomes aware and which might be relevant to patentability. This is a legal requirement and non-compliance by the patent applicant can lead to subsequent revocation of the patent. This has led to an inflation of submitted prior art, to which the USPTO reacted in 2005 by encouraging applicants to limit the number of submitted references to 25. These institutional differences explain in part why the number of citations is notably higher in each USPTO patent than in patents from other offices (Table 3.2).

- Since 8 June 1995, the United States Patent and Trademark Office (USPTO) has offered inventors the option of filing a provisional application for patent which was designed to provide a

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21 Patents which were applied for prior to 8 June 1995, and which where or will be in force after 8 June 1995, have a patent term of 17 years from the date of patent grant or 20 years from the date of filing of the earliest related patent application, whichever is longer.

lower-cost first patent filing in the United States. It is a patent application which does not mature into an issued patent unless further steps are taken by the applicant. A provisional application allows filing without a formal patent claim, or any information disclosure (prior art) statement. It provides the means to establish an early effective filing date in one or more continuing patent applications later claiming the priority date of an invention disclosed in earlier provisional applications by one or more of the same inventors. [22]

- Applicants have the possibility, after application, to make quite substantial amendments to their initial filing, following the progress of their research or in reaction to examiners' requests. This procedural step is iterated as long as the applicant continues to make appropriate amendments; in consequence, the grant can be delayed. The continuation-in-part (CIP) type of application result from a second or subsequent application being filed, which includes new material protected, while the original application is pending.

- If an issued patent is found to be defective, then the patent owner can surrender the patent and re-file the original application to correct the defect. One such defect is that the issued patent fails to claim the full scope of the invention. Thus an inventor can re-submit the patent application with broader and/or new claims and attempt to get the full coverage they are entitled to. They are not, however, allowed to add new features to their invention. A re-issue application that attempts to get broader coverage than the original issued patent must be filed within two years from the grant date of said original issued patent.

3.3.2 JPO

63. The patent statute of Japan has been reformed several times since the late 1980s, bringing it closer in line with other countries' statutes. Major specificities with implications for statistics are as follows:

- The JPO grant patents under the *first-to-file* system, *i.e.* the principle that where two parties apply for a patent for the same invention, the first party to file will be granted the patent.

- Japan has also a *"grace period"*. Up to six months before the filing, the invention, which has been published or presented at an academic body designated by the Commissioner or has been displayed at an exhibition held by a government or a body designated by the Commissioner, is not regarded as having lost novelty.

- The JPO publishes the content of an application in the Official Gazette after 18 months have elapsed from the date of priority.[23] However, a request for examination has to be filed within three years of the application date to start the substantive examination process. The time limit for the request for examination was reduced in 2001 from seven years to three years (three years for patents filed since October 2001 and seven years for patents filed before October 2001). If the applicant fails to file the request for examination within the time limit, the application is regarded as withdrawn.

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22 Because no examination of the patentability of the application in view of the prior art is performed, the USPTO fee for filing a provisional patent application is significantly lower than the fee required to file a standard non-provisional patent application.

23 At the JPO, since 2000 applicants can request early publication of the patent application within 1.5 years of the date of filing in order to deter imitation by third parties since the claim of compensation for infringement arises on the date of publication.

- The long time given to applicants to decide whether to request examination or not might be one reason for the large number of applications to the JPO compared with other jurisdictions, as inventors could go for over eight years before having to make a decision. This rule change also explains the surge in the number of examinations requested (and grants) after 2004, due to a sort of "calendar effect". This high number can be explained also by the *"one claim rule"* which prevailed in Japan until 1975. The current unity of application is the same as the *unity of invention* in other jurisdictions (as defined in PCT). This essentially permits groups of linked inventions to form a single inventive concept to be examined in a single application. In spite of these reforms, applications to the JPO still have a significantly lower number of claims than in other patent offices. An inventor might need to file several applications at the JPO as opposed to only one at other offices in order to obtain the same level of protection,. However, since applicants try to secure broad and strong rights for their technology, the number of claims per application has risen since the late 1980s.

- At the JPO, renewal fees are due as a lump-sum fee for the first three years and each year from the fourth year of the date of grant. The requirement for applicants to disclose information on prior art in applications was introduced as of 1 September 2002 and entered full force on 1 May 2006. Patent examiners conduct the prior art search. There is no limitation on the number of references to be included.

- Patents granted by the JPO can be appealed by third parties. Even after a patent is registered, any person may appeal for invalidation of the patent if it has a flaw. This system was introduced in 2003 when the post-grant opposition system was abolished and the invalidation trial system was revised (effective from 1 January 2004). Under the new invalidation trial procedure, *i)* the trial may be demanded at any time; *ii*) both parties are involved in an *inter partes* procedure during the trial; and *iii)* the plaintiff may appeal against a verdict upholding the patent in question to the Tokyo High Court.

3.3.3 EPO

64. The Convention on the Grant of European Patents, widely known as the *European Patent Convention* (EPC) was signed in 1973 and entered into force in 1977. As a result of the EPC, the European Patent Office (EPO)[24] was created to grant European patents based on a centralised examination procedure. By filing a single European patent application in one of the three official languages (English, French and German), it is possible to obtain patent rights in all the EPC countries.[25]

- Patents granted by the EPO have the same legal rights and are subject to the same conditions as national patents (granted by the national patent office) in each EPC country for which the patents have been granted. Once granted by the EPO, a European patent is therefore a **"***bundle***"** of national

24 The EPO is not an institution of the European Union. At present there is no single EU-wide patent, although since the 1970s there has been concurrent discussion towards the creation of a *"Community patent"* within the European Union. In its Communication to the European Parliament and the Council (3 April 2007 COM, 165 Final) "Enhancing the patent system in Europe", the Commission "*is of the opinion that the creation of a single Community patent continues to be a key objective for Europe*". In view of the difficulties in reaching an agreement on the community patent, other legal agreements have been proposed outside the European Union legal framework to reduce the cost of translation (of patents when granted) and litigation, namely the London Agreement and the European Patent Litigation Agreement (EPLA).

25 As of 2007, 32 countries are party to the treaty. In addition, the EPO has an "extension agreement" with five countries, which allows the possibility of extending European patents to those countries upon request at the time of European patent application.

patents, which must be validated at the national patent office of the designated states for it to be effective in EPC member countries.[26] Within three months of the grant of a European patent, the applicant has to complete various formalities. For example, the national patent office of a designated state might require the applicant to provide a translation in one of its official languages and pay for the publication fees of the patent.

- A European patent application can originate from: *i)* direct filing to the EPO without a priority claim (*i.e.* first filing), *ii)* extension of an earlier national patent application (within 12 months of first filing), *iii)* or, from an international application filed using the PCT procedure. The first two categories are known as "Euro-direct" while the third one is "Euro-PCT". Figure 3.2 illustrates these different patenting routes involving the EPO. Since the early 2000s, patent applications coming from national offices to the EPO have significantly decreased over time in total applications filed at the EPO. Indeed, the majority of the EPO patent applications originated from the PCT (Euro-PCT). In 2006, the rate of all PCT applications entering the national-regional phase was 62% at the EPO while at the USPTO and JPO, this figure was 46% and 45%, respectively (Trilateral Statistical Report 2006).[27] A similar pattern is found in terms of the share of PCT in total granted patents by trilateral patent offices: in 2006, 52% of patents granted by EPO were PCT applications, while this share was 11% at the UPSPTO and 5.1% at the JPO (ibid).

- This complex legal setting is a source of statistical difficulty, notably when counting "national patents" and "national applications" in European countries. Strictly speaking, all applications to the EPO since 2004 are also national applications, as the applicant has the right, in case of a grant, to obtain a patent in the country concerned. This also applies if the applicant has no intention of seeking protection in that particular country, as happens in a majority of cases for small European countries. Hence, the notion of a "national patent application" is blurred. This is not, however, specific to European countries, as a similar principle of automatic designation is now in place at the PCT (see Section 3.4.2). As a result, if one wishes to compile exhaustive statistics on national applications in a given country, one has to use national, EPO and PCT data all together. In addition, in Europe patents valid in any country include not only those examined and granted by the national patent office, but also those granted by the EPO and validated nationally.

65. Other specificities of the EPO procedure include:

- Contrary to the USPTO, the submission of references to the prior art when filing an application is facultative. Examiners are responsible for constructing the list of prior art references (provided in the search report) against which patentability is judged. The European search report should include as references the most important documents or the earliest publication of equally important documents. According to EPO philosophy, a good search report contains all relevant information within a minimum number of citations.

- Once the European search report has been published, the applicant has six months to file a request for examination and pay the corresponding fees; otherwise the application is deemed to be withdrawn.

[26] If the amount paid for designations is at least equivalent to seven times one designation fee, then all the contracting states are automatically considered designated, but the applicant can still remove any of them.

[27] As a result, higher proportions of PCT applications passing to the phase II are registered at the EPO. This is due to the supranational dimension of the EPO, which provides an opportunity to proceed with a unique procedure for several countries.

- An opposition to patents granted by the EPO can be filed by third parties within a period of nine months following the grant. This process is an interesting source of statistical data. As opposition is a costly process, it is likely that patents which are opposed are the ones which create more difficulty (potential economic costs) to competitors, hence those with higher value. The fact that a patent is opposed can therefore be seen an indicator of high value (Harhoff and Reitzig, 2002).

3.4. International patent applications

3.4.1 The priority principle

66. The earliest international treaty on the protection of invention dates back to 1883 (*the Paris Convention for the Protection of Industrial Property*), with 169 signatory countries as of January 2005. The Paris Convention established the system of *priority rights*, under which applicants have up to 12 months from first filing their patent application (usually in their own country) in which to make further subsequent applications in other signatory countries and claim the priority date of the first application. Prior to the Paris Convention, foreign applications could be refused on the ground that the invention was no longer novel as it had been disclosed in an earlier (priority) application.[28]

67. The priority rights rule has important implications for the calculation of patent statistics, because in most countries there will be a time lag of *12 months* between domestic and foreign application dates corresponding to inventions performed at the same time. This is to say that for a domestic application the "priority date" is equivalent to the "application date" and for foreign applications there is a 12-month lag between the "priority date" and the "application date". If the application date is used to reflect the time period of the invention, it will introduce a bias in the timing of domestic and foreign inventions. The priority date will reflect the proper time period of the discovery of both domestic and foreign inventions. For this reason, when compiling patent statistics to reflect inventive activities, it is recommended to use the priority as the reference date.

3.4.2 The Patent Cooperation Treaty (PCT)

68. The Patent Cooperation Treaty (PCT) was signed in 1970 and entered into force in 1978. It is managed by the World Intellectual Property Organization (WIPO). As of 31 July 2006 there were 133 contracting states to the PCT. The PCT does not deliver patents. Instead, the PCT procedure provides the possibility to seek patent rights in a large number of countries by filing a single international application (PCT application) with a single patent office (receiving office) and then entering the national stage in the desired countries at a later date.[29] Recall that all applications (international or regional) must ultimately have a national status, *i.e.* they need to be validated (granted) in the national patent offices where patent protection is desired.

69. In functional terms, the PCT procedure gives the applicant the possibility to delay the national or regional procedures and thereby postpone the respective fees and translation costs up to 30 months after the priority filing. The applicant can therefore benefit from more information (regarding the prospective value of the patent) before incurring the high cost of filing applications in a large number of national offices. In that sense, a PCT application can be considered an option for future applications to patent offices around the world.

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[28] Furthermore, an applicant is entitled to claim priority even if the information in the subsequent application is not exactly the same as the earlier application, or if there are several "priority" applications combined into a single foreign application. As a result, when considering priority claims, one can expect different numbers of applications to have been filed in various countries.

[29] In this manual we use the terms "PCT application" and "international application" interchangeably.

70. The PCT application starts with filing of an international application either at the national (or regional) patent office or with WIPO. This has to be done in the 12-month period following the priority filing, but it can be done immediately as a priority filing itself. The applicant must be a national or resident of one of the PCT signatory states. A PCT application automatically includes all PCT signatory states as "*designating*" states (designating states are countries in which the applicant wishes to protect his invention).[30]

71. After receipt at WIPO, the application is transmitted to one of the appointed *International Search Authorities* (ISA), which are patent offices appointed by WIPO (including for example, the EPO, JPO and USPTO). The ISA prepares an *international search report* (ISR), which is published at the same time as the application. It is built in the same way as the search reports for the national procedures. The ISR lists references to published patent documents and technical journal articles that might affect the patentability of the invention. The ISR is normally provided by the ISA to the applicant nine months after the filing of the application in the event of a first filing and 16 months after the priority date in the event of a subsequent filing (*i.e.* claiming the priority of a first filing). In addition to the ISR, since January 2004, a detailed written opinion on the patentability of the claimed invention is produced (the WOISA, written opinion of the ISA). The WOISA is a non-binding opinion on whether the invention appears to meet the patentability criteria in light of the search report results. The international application and the international search report (ISR) are published after a period of 18 months from the priority date has elapsed (written opinions are not published).

72. After receiving the ISR and the WOISA, the applicant can also request an international preliminary examination (IPE), which will generate an *international preliminary report on patentability* (IPRP). IPRP is a second evaluation of the potential patentability of the invention. The request for an IPE must be filed within 22 months of the priority date (or three months after the issuance of the ISR, whichever date comes later). If the applicant does not request an international preliminary examination, the WOISA will be converted into an IPRP.[31] Finally, at 30 months from the priority date, the international phase ends and the international application enters the national or regional phase where the applicant wants to actually apply for a patent.[32] Recall that all international or regional applications must ultimately have a national status.

73. In the case of the PCT it should be noted that after the transfer to the national or regional phase, it takes approximately six more months until this step is published at the regional/national office. In the case of Euro-PCT the information on the effective transfer to the EPO is available 36 months after priority (first filing). The late availability of this information strongly influences the computation of patent statistics and timeliness of patent indicators at national patent offices. [33] In the next chapter, the issue of timeliness is discussed and various methods for "now-casting" patent applications are briefly presented.

30 Until January 2004, the applicant had to designate on the application form a specific list of countries where protection might later be sought. This obligation was then removed (but applicants can list countries where they do not intend to seek protection, although that will not change the application fees).

31 The IPRP provides the applicant with additional information on the patentability of inventions; therefore, applicants are in a better position to decide whether it is worthwhile to proceed to the national/regional phase.

32 However, any national law may fix time limits which expire later than 30 months. For instance, it is possible to enter the European regional phase at 31 months from the priority date. National and regional phases can also be started earlier on the express request of the applicant (Art. 20(3) or 40(2)).

33 In the Continuations case (e.g. CIP in United States) the lag between priorities (first filing and filing in other countries) can be longer (in general all priorities refer to one year after the first priority); which will then impact on the timeliness of publication of patents at other jurisdictions.

Box 3.1 Patentability Criteria

- **Subject matter:** To be patentable, an invention must fall into certain fields of knowledge, which one may characterise approximately as being "technology". The law is more specific on that, and varies somewhat across jurisdictions. Aesthetic creations, laws of nature and abstract ideas are excluded in all jurisdictions. Software is patentable in the US, as well as business methods. The practice in these two fields is more restrictive in Japan and even more in Europe (which excludes "software as such").
- **Novelty:** To be patentable, an invention must be novel in the absolute sense. That means it was not available to the public in any way before the filing date of the patent, and was not described in any publication before that date either. In most of the cases, the complete invention must be described in one single document for that document to be considered novelty-destroying. Novelty is a worldwide concept; an invention is deemed not to be new in one country if similar prior art is found in another country, in any language, in any period of time.
- **Non-obviousness/Inventive step:** Even if an invention is found to be novel in the strict sense, it may still be unpatentable when it is considered to be obvious to a person having ordinary skill in the art. The term *obvious* is a legal term of art, and is thus used in a sense quite different from country to country. The inventive step and non-obviousness reflect a same general patentability requirement present in most patent laws, according to which an invention should be sufficiently inventive, *i.e.* non-obvious, in order to be patented. The expression "*inventive step*" is predominantly used for instance in Germany, in the United Kingdom and under the European Patent Convention (EPC), while the expression *"non-obviousness"* is predominantly used in United States patent law. In the United States, it is argued that something is obvious if the differences between the subject matter to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skills in the art to which said subject matter pertains. In Europe, patent application involves an inventive step if it solves a technical problem in a non-obvious way.
- **Industrial applicability:** This requirement mainly aims to distinguish between aesthetic and scientific inventions. The term "industry" is interpreted in a broad sense; it also includes agriculture, for example. It does exclude methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practice on the human or animal body. The so-called perpetual motion machines also fail to meet this requirement. In the United States, this requirement is referred as "utility"; however, the interpretation and scope of this term is generally the same as that of the industrial application. International patent treaties often use "utility" and "industrial applicability" as synonyms.

Box 3.2. Main provisions of the TRIPs Agreement

The objectives of the TRIPS are defined in Article 7: "*The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations."* Unlike other international agreements on intellectual property, TRIPS introduced a dispute settlement mechanism, which is capable of authorising trade sanctions against non-compliant states. Specifically, TRIPS deals with harmonisation copyright and related rights, such as rights of performers, producers of sound recordings and broadcasting organisations; geographical indications, including appellations of origin; industrial designs; integrated circuit layout designs; patents, including the protection of new varieties of plants; trademarks; trade dress; and undisclosed or confidential information, including trade secrets and test data. Articles 3 and 4 set down the two main principles of treatment for WTO members:

- ***National Treatment (art. 3):*** Each Member shall accord to the nationals of other Members treatment no less favourable than that it accords to its own nationals with regard to the protection of intellectual property, subject to the exceptions already provided in, respectively, the Paris Convention (1967), the Berne Convention (1971), the Rome Convention or the Treaty on Intellectual Property in Respect of Integrated Circuits.
- ***Most-Favoured-Nation Treatment (art. 4):*** With regard to the protection of intellectual property, any advantage, favour, privilege or immunity granted by a Member to the nationals of any other country shall be accorded immediately and unconditionally to the nationals of all other Members.

Table3.1. Differences between the three main patent offices

	EPO	JPO	USPTO
Patent grants are based on:	First to file	First to file	First to invent
Patent duration:	20 years	20 years	20 years
Application language:	English, French or German [a]	Japanese [b]	English [c]
Area covered:	EPC member and “extension” countries[d]	Japan	United States
Request for examination:	Yes, within 6 months	Yes, within 3 years [e]	No
Publication of application:	18 months from the priority date	18 months from the priority date	18 months from the priority date[f]
Are there some subject matters excluded from patentability or not considered to be inventions?	Yes[g]	Yes[h]	Yes[i]
Opposition system:	Yes [i]	No	No[k]

a. An application can be submitted in any official language of any EPC member state. However, within three months of filing the application, but no more than 13 months after the earliest priority date, a translation of the application into one of the official EPO languages (English, French or German) is required.

b. It is possible to file a patent request in Japanese and the specification, claims, drawings and abstract in English. A Japanese translation of the English documents must be filed within 14 months of the initial filing date.

c. Possible to file in any language other than English provided that English translation is submitted within two months.

d. A European patent does not automatically provide protection in all EPC member countries (or the extension countries). The applicant has to validate its EPO patent, once granted, separately at the respective national patent offices for the patent to be effective in those countries.

e. Request for examination period: three years for patents filed since October 2001 and seven years for those filed before October 2001.

f. An application that has not and will not be the subject of an application filed in foreign countries does not need to be published if an applicant so requests.

g. Subject matters not considered to be inventions are: discoveries, scientific theories and mathematical methods; aesthetic creations; schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers; and presentations of information. Subject matter excluded from patentability: plant or animal; and methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practiced on the human or animal body.

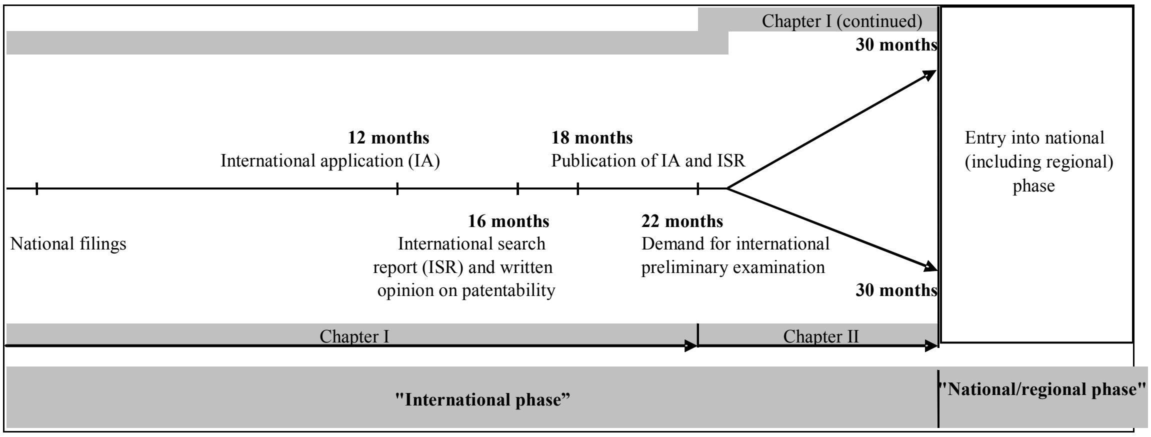
h. Subject matters not considered to be inventions are: discoveries; scientific theories and mathematical methods; mental activities; mere presentation of information; business methods; isolated parts of human beings; and diagnostic, therapeutic and surgical methods for the treatment of humans and animals.

i. Subject matters not considered to be inventions are: scientific theories and mathematical methods; mental acts; presentation of information; and traditional knowledge.

j. Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the EPO of opposition to the European patent granted. Opposition can only be filed on the following grounds: the patent’s subject matter is not patentable; the patent does not disclose the invention clearly and completely; or the patent’s subject matter extends beyond the content of the application as filed.

k: Re-examination procedure; post-grant review of the validity of the claims of a patent in view of a prior art patent or printed publication believed to have a bearing on the patentability of any claim of the patent in question. The patent owner or any third party may request re-examination at any time after grant.

Figure 3.1. Timeline for PCT procedures



CHAPTER 4

BASIC CRITERIA FOR COMPILING PATENT-BASED INDICATORS

4.1 Introduction

74. To compile patent statistics, certain methodological choices have to be made. The challenge faced by statisticians is to select the relevant variables for compiling statistics, among many alternatives. The methodological choices have significant influence on the derived statistics and interpretation of the statistics. Patent statistics can only be interpreted in a meaningful way if there is adequate knowledge of the criteria and methodologies used to compile them.

75. The decision to select one criterion over another is dependent on the phenomena that are to be measured and user needs. As an example, different indicators of the number of patent applications to the patent office of country A can be designed in order to reflect the inventive performance of other countries, the market power of entities from various countries in country A (patent portfolio ownership), or the attractiveness of country A's patenting system, etc. In particular, if the aim is to measure the inventive performance of countries, then the criteria for calculating the indicator ought to be the inventor's country of residence, whereas if the aim is to measure ownership of inventions, then applicant's country of residence is the most appropriate criteria. Likewise, if the goal is to evaluate attractiveness of countries for protection, then the country (or countries) of filing patent protection is the most adequate approach.

76. The most common basic methodological choices that are associated with compiling patent statistics are: the reference date, the country of attribution, and the treatment of internationally comparable aggregates (PCT, families). More refined indicators based on these criteria can be considered by technology area, region, institutional origin, etc.

77. As a general rule, it is recommended not to put together indicators coming from different patent offices. For instance, the number of patents applied for in Korea by Korean applicants is not comparable to the number of patents applied for in Australia by Australian (or even Korean) applicants. As we will see in more detail, legal and administrative procedures differ across patent offices, and there is a home bias in the behaviour of applicants (domestic applicants tend to file more patents in their home country than non-resident applicants). Hence the analysis in this chapter applies to data drawn from a single office (or to patent families).

4.2 Reference date

78. The problem in choosing the year to which a patent is attributed is that every patent document includes several dates, reflecting the timing of the invention, the patenting process and the strategy of the applicant (Dernis *et al.*, 2001; Hinze and Schmoch, 2004).

- The **priority date (**first date of filing of a patent application, anywhere in the world, to protect an invention) is the earliest and therefore closest to the invention date. Recall from Chapter 3 that there are several routes for filing a patent application. The process of patent protection starts with a *first filing*; an initial patent application prior to any *subsequent filing* to extend the protection to other countries.

- The **application date** is the date when a patent is filed at a specific patent office. There is a 12-month lag between residents and foreigners for traditional direct procedures and up to 30 months for PCT procedures. Usually, an applicant will file an application at the national office (this generates the priority date) and later extends this application to other countries either by filing application directly to the relevant patent offices (this generates the application date with up to a 12-month lag with the priority date) or by filing a patent application using the PCT procedure (the lag is 12 months for the PCT filing itself, and up to 30 months for the transfer to the national phase).[34]

- The **publication date** (18 months from the priority date except for certain applications to the USPTO, published only if/when granted) reflects the time when information about the invention is disclosed to the general public and made available to statisticians.

- The **grant date** is the date when patent rights are conferred to the applicant by the authorised body. It takes three years on average at the USPTO and five years at the EPO for a patent to be granted, but can take up to ten years in some cases.

79. For the purpose of reflecting inventive performance, indicators based on application and/or grant date suffer from a range of biases associated with the patent process: data are dependent on various administrative delays (*i.e.* examination process), strategic behaviour of the patentee, and the data are not comparable across countries as the lag between priority date and application (or grant) dates differs from country to country. Country A's inventors will usually file applications in the patent office of country A immediately after the invention occurred, whereas foreigners will apply one year later (priority year): hence counting the two types of inventions by year of application means that inventions from different years are compared, which can introduce biases in times of rapid change or for rapidly growing countries.

80. As for the use of the **grant date**, it means *i)* that the counting is restricted to grants (excluding non granted applications), *ii*) the information reported is already in the past (it takes three to five years on average to grant a patent), *iii)* inventions from many different years are counted together. At all offices, there is a processing and examination time, which can be very long in some cases. In consequence, statistics based on granted patents are not strictly comparable across patent offices as there is high variability in the time needed to grant a patent within each patent office. In addition, as patent offices have been faced with a surge of their workload since the mid-1990s, the procedure has tended to lengthen, so that the number of grants would reflect the underlying dynamics only in a smoothed and delayed manner ("calendar effect").[35]

34 In the case of PCT it should be noted that after the transfer to the national or regional phase, it takes approximately six more months until this step is published at the regional/national office. In the case of Euro-PCT the information on the effective transfer to the EPO is available 36 months after priority (first filing).

35 The reporting of data by year of grant is especially common for USPTO patents, for the reason that until 2002 the USPTO would publish only granted patents, not applications. However, even in that case, the grant year generates biased information regarding inventions.

81. One of the most meaningful dates from a technological or economic point of view is the **priority date**. It is the closest to the date of invention. Other details result from legal constraints (first priority) and administrative delays. There is evidence that companies which choose to patent an innovation do so early in the process, so that they have the option of withdrawing their filing later if the invention turns out to be disappointing.

82. Hence for reflecting inventive performance it is recommended that the priority date should be used to compile patent statistics. Depending on the patent indicator you are interested in, *e.g.* publication activity by the patent office (publication date) or legal status of patenting (grant date), the other criteria are also meaningful. Yet they are less informative indicators of the performance of countries.

83. Table 4.1 illustrates how the choice of date affects the patent indicators. The total number of patents granted at EPO to OECD countries in 2000 was 27 139 if the date of grant is taken as the reference date for granted patents; this number is 31 210 if the priority date is chosen as date of reference. Likewise, for patent applications more patents are recorded on the basis of priority date compared to the application date: 146 242 patents are recorded under the first date whereas it is a total of 134 410 if we use the application date. The average discrepancy between counts by priority date and counts by application date (for patent applications) was 9% in 2000 across OECD countries. For grants, the discrepancy was more important: 28%. The statistics for granted patents at the EPO show the impact of the choice of date on cross-country comparisons. For granted patents, if we consider the year 2000 as the priority date, Germany shows the highest percentage of patents within OECD countries, followed by the United States. The order is reversed if we compute the count of patents according to the grant date: the United States reports the largest share (26%) followed by Germany (20.6%) and Japan (20.3%). In terms of patent applications, the United States has by far the largest share of patent applications (33.8% and 33.7%, under the priority date and application date criteria, respectively).

4.3 Reference country

84. A patent document includes information on the inventor's country, applicant's country and priority country (country where first filing was made). These are all useful approaches and a comparative examination of their meaning is informative.

- **Patent counts by applicant's country of residence** designate "ownership" or control of the invention (*i.e.* the number of patents owned by residence of each country). Indicators of this type reflect the innovative performance of a given country's firms, regardless of where their research facilities are located.

- **Patent counts by the inventor's country of residence** indicate the inventiveness of the local laboratories and labour force of a given country. The address given in the patent document is usually the professional address of the inventor (the address of the lab the inventor works in).

- **Patent counts by priority office** (country where the first application is filed, before protection is extended to other countries) indicate the attractiveness of a country's patenting process, the quality of intellectual property regulations (rules and cost of patenting), the reputation of the patent office and general economic features (*e.g.* market size). For instance, many Canadian firms file for patents first in the United States, followed by a possible extension in Canada at a later stage.

85. **It is recommended that the inventor's country of residence should be used to compiled patent statistics for reflecting inventive activity.** The country of residence of the applicant is useful for analysing the market allocation strategy of companies, notably multinational ones.

86. A usual difficulty when compiling indicators by country of residence of the applicant is that the patent could be taken by an affiliate of the entity having control on the invention. Certain large multinational firms have affiliates specialised in patent filing, which can even be located in a different country than the parent company, hence creating noise in the data. The location of such affiliates' applicants can also be guided by fiscal and other considerations. In such cases it is preferable to attribute the patent to the controlling entity (parent company), which requires matching the patent data with ownership information coming from other sources.

87. Table 4.2 illustrates the impact of these criteria on patent statistics. It reports OECD country shares in applications to the European Patent Office (EPO) using different count criterion for geographical distribution. Higher shares as inventor country are reported by small countries such as Belgium, the Czech Republic, Hungary and Mexico (the percentage of difference respect to total inventions rank between 15 and 27%). Inversely, the Netherlands, Switzerland or Finland have more patents as applicant countries than as inventor countries. This reflects their higher level of internationalisation of research activities (domestic ownership of inventions made abroad). A notable exception concerns Luxembourg, whose share in respect to total OECD as applicant country doubles the one in terms of inventor country.

88. **Patents with multiple inventors from different countries.** In recent years there has been an increase in the level of co-operation among researchers from different countries, reflecting the openness and internationalisation of S&T activities. This information is found in patent documents where more than one inventor coming from different countries is listed. Such patents can either be partly attributed to each country mentioned (fractional count) or fully attributed to every relevant country. Fractional counting can be used if multiple inventors (or applicants, or IPC classes) are provided in the patent data to credit each unit of analysis with its correct proportion and avoid double counting.

89. In particular, fractional counting can be used to compile patent statistics as it will reduce the bias of double counting if regional or world totals are computed, but whole counting is sometimes preferable depending on the policy question to be addressed (*e.g.* for the measurement of internationalisation of technological activities by countries).[36]

4.4 PCT applications

4.4.1 Counting PCT applications at the international phase

90. Patent indicators constructed on the basis of information from a single patent office show certain weaknesses. The "home" advantage bias is one of them, since, proportionate to their inventive activity, domestic applicants tend to file more patents in their home country than non-resident applicants. The relative share of foreign applicants is affected by factors not directly related to technology, such as the density and orientation of trade links between each of these countries and the country where patents are taken: higher exports or higher direct investment from country A towards country B will trigger higher patent numbers from applicants of country A to be taken in country B, so as to protect their technology. Two types of patent indicators are relatively free from this type of bias and are therefore more appropriate than national or regional filings for cross-country comparisons: PCT applications and patent families (the latter is addressed in section 4.5).

[36] For instance, if the object of examination is the inventiveness of one single country (or region or industry), fractional counting based on inventors' country of residence might not be relevant and whole counting would be more appropriate, The use of fractional counting is convenient for aggregation purposes but is also questionable as it raises the question for instance, to what extent a fraction of a patent with multiple inventors might be less valuable for a given unit of analysis (country or region, etc.) than those with a single inventor.

91. The Patent Cooperation Treaty (PCT) procedure is international by design and is administered by the World Intellectual Property Organization. Each application filed through the PCT designates all signatory states of the PCT – this has been the case since 2004; before that a list of designated states had to be provided by the applicant and the fees would vary according to the number of designated states. In that setting, a PCT filing can be seen as a "worldwide patent application" and is much less biased across countries than national applications. A further advantage of the PCT is that it is increasingly used by applicants of all member countries. This expanding number makes PCT a basis of increasing relevance for drawing statistics. Since the early 2000s, most countries are well represented, including Japan and Korea (which came late to using the PCT procedure). Further, PCT reflect technological activities of emerging countries quite well (Brazil, Russia, China, India, etc.). It should be taken into account that PCT started being used more broadly after 1990, so there is a transition period until about 2000 where cross-country comparison or time trends have to be interpreted with care.

92. PCT information has two drawbacks: first, it is not completely free of biases as applicants make uneven use of it across countries, due to some legal constraints or economic reasons. Second, PCT are not patent applications in the same sense as national applications. They are rather options for future applications to patent offices around the world, as the PCT procedure consists of two phases: an international phase possibly followed by a national/regional phase (see Chapter 2 for details). The relatively low cost of a patent application on an international basis makes the PCT procedure little selective –in case of uncertainty regarding the value of their invention applicants can file an application "just in case" and postpone the decision, with the associated higher cost, of a real filing for later. Hence many PCT applications will cover inventions whose value is known, *ex-post*, to be low. Indeed, a fair share of PCT applications is never transferred to the national phase. This magnifies the drawback of patent counts as treating equally inventions of extremely uneven value. It should also be noted that even if the costs are lower than the application in many countries in parallel, the costs of application through PCT are still relevant and higher than for domestic applications.

4.4.2 Counting PCT applications at the national phase

93. The two-phase procedure of the PCT has important implications for compiling patent statistics. Should the international phase data, which are the only option for future applications, be reported along other, standard, national applications? Or should only those PCT application proceeds to the national/regional phase, where the decision is made on whether to grant or reject patent rights, be reported? Likewise, the system of designation for the PCT application has an implication for reporting patent statistics. Should all designated states be counted when compiling PCT applications at national level? Or only those designated countries where the PCT application proceeds to the national/regional phase?

94. For some countries, taking into account international phase data would alter the share of national patenting by a large extent (see Figures 4.3 and 4.4). For instance, for a country with 10 000 national applications a year (a large majority of countries have less than that), the inclusion of PCT applications (more than 100 000 applications a year) will totally dilute the significance of national statistics, especially as most of these PCT applications will not be transferred to the country so that they will never become real national applications. Available statistics show that a large proportion of initial PCT applications do not proceed to the national/regional phase (OECD, 2005).

95. However, a major drawback of including only the PCT applications which enter the national or the EPO regional phase is that it will adversely affect the timeliness of patent indicators. It may take up to 31 months from the priority date (*i.e.* the date of first filing of a patent application anywhere in the world)

for PCT applications to enter the national or regional phase. Hence no patent statistics taking this more selective approach could be produced within 30 months after the date of interest.[37]

4.4.3 Nowcasting patent applications

96. One solution to the timeliness problem in PCT application is to estimate ("now-cast") the number of PCT applications which will be transferred to a particular country. There are different ways to "nowcast" filings (see Box 4.1). To nowcast Euro-PCT filings, one way is to predict filings based on the transfer rate of patents filed under PCT into the EPO regional phase, given that information on PCT patents at international phase is disclosed before reaching the regional/national phase (Schmoch, 1999). A two=step nowcasting procedure can be implemented based on the transfer rate (see Box 4.2; Dernis, 2007).

97. Forecasting patent applications is very useful for patent offices to plan future demand for services. There are a number of regression and survey approaches that can be taken (see Box 4.1). Regression methods have the disadvantage that the forecasts are based solely on historical data and therefore assume the continuation of established trends. Straight line regression models can be fitted to annual filings totals, though a more useful extension involves trends of worldwide first filings and then monitoring their percentage transfer abroad to other offices within a year according to the Paris Convention principles of filings quoting an earlier priority. There are also interesting possibilities to model worldwide patent filings simultaneously at different offices via an approach based on the analysis of international priority filings based patent families. Econometric approaches are also used and typically involve the use of predictor variables such as GDP and R&D expenditures or R&D labour counts in the most important source countries for filings, together with ARIMA-based time series error structure on the various input and output series. Short-term forecasting of demand from monthly filings counts can also be useful for more detailed planning purposes, and offices also of course need to make workload forecasts for various stages of their examination procedures.

98. Surveys of applicants have the advantage that changes of opinion about patent filings practices can be picked up relatively quickly. At least each of the trilateral offices does surveys of its own clients on an annual or two-yearly basis. Typically the sampled respondents are asked to quote their actual and forecasted patent filings for the previous year and up to three years in the future. The resulting growth rate estimates can be pooled and averaged in various ways in order to come up with short-term quantitative forecasts of future patent filings. While this method allows for offices to rapidly respond to changes of trends, the survey-based forecasts themselves may not be quite as good as the regression-based methods in normal circumstances, because regression is a method that institutionalises established trends. Surveys also have the advantage of being able to collect concomitant micro-economic information on applicants that can be useful to the patent offices in other ways to help find out more about the needs and natures of their clients.

4.5 Patent families

99. Patent families are another way of working out patent indicators which are comparable across countries. The set of patents (or applications) filed in several countries which are related to each other by one or several common priority filings, is generally known as a patent family. It is also often considered that a patent family comprises all patents protecting the same invention, although depending on the family definition and how far the links among family members are stretched, this can be more or less true.

[37] There are some patent office procedures during the international phase that can affect the choice by the applicant whether to go to national/regional phase, notably the international search report and the international search opinion; there is also the publication of the application at 18 months after priority, etc. Possibly after one of these stages, the applicant might want to drop out before this to maintain secrecy.

Differences in national patent systems and procedures can lead to differences between the scope of protection applied for and granted in first and subsequent filings. This section presents some commonly used patent family definitions, noting that this is an area of ongoing research where new definitions are explored by researchers and practitioners to better reflect applicant strategies (see Box 4.3).

100. The scope and composition of a patent family depends on the kind of priority links, types of patent documents and patent offices considered in its definition. One particular type of family is the **triadic patent families** (Grupp *et al.*, 1996). According to the OECD definition (Dernis *et al.*, 2001), a triadic patent family is a set of patent applications filed at the EPO and the JPO, and granted by the USPTO, sharing one or more priority applications. The restriction to USPTO grants (instead of applications) is due to the non-publication of applications by the USPTO until 2001, which rendered impossible such applications-based statistics. Another type of family is that used in the Trilateral Report which counts all priorities filed, each being considered as a family. This method is useful for building statistics on flows from place of first filing to activities in other offices using Paris priorities.

101. In terms of statistical analysis, triadic patent families improve the international comparability of patent-based indicators, as only patents applied for in the same set of countries are included in the family; home advantage and influence of geographical location are therefore eliminated. Second, patents included in the family are typically of higher value; patentees only take on the additional costs and delays of extending protection to other countries if they deem it worthwhile. By introducing *de facto* a cut-off point regarding the value of patents included in this set, the upper tail of the distribution of patents by value is selected (in terms of worldwide application), hence making patent family counts more informative than national or regional counts.

102. To count triadic patent families to reflect inventive performance, it is recommended to use the earliest priority date (first application of the patent worldwide), the inventor's country of residence, and fractional counts (see Figure 4.2).

103. A quite restrictive patent family definition is that of **patent equivalents**, which considers only patent documents sharing exactly the same priorities. This would correspond to a case where an applicant files first for protection in his home country with a single application (single priority filing) and within a year files for protection in other countries. According to the Paris Convention rules he has the right to claim the priority of the filing he did in his home country, so all his subsequent filings would be equivalents with the priority. Patent equivalents are usually considered to be the most closely related patent family members and thus those most likely to be protecting the same invention.

104. One drawback of OECD triadic families is their weak timeliness. For the USPTO, average time between application and grant is about 35 months, but can extend to 44 months. Therefore, no complete statistics of triadic families are available before at least around three years after the date of interest. This disadvantage can be remedied by "nowcasting" patent families (see Section 4.4.3), *i.e.* using available information from the past to estimate the most likely numbers of families which will emerge (Dernis, 2007). As previously described, a two-step method can be implemented, extending triadic patent families' coverage up to year t-3, possibly year t-2.

105. When compiling international indicators, one is faced with the choice between PCT applications and patent families. The choice will depend on the required timeliness and quality of the indicators. PCT have an advantage in terms of timeliness (they are published 18 months after priority) whereas families have an advantage in terms of quality (inventions of high value aiming to cover main international markets are selected).

106. There are alternative definitions of patent families (see Box 4.2). The Trilateral Report for instance counts all priorities filed, each being considered as a priority. Depending on what analysis is sought, a different concept of family will be chosen. If one wants to take into account, for instance, smaller inventions with an essentially local market, the "all priorities" definition will be preferred to the triadic families, as the latter purposively eliminate such small inventions. If one instead wants to compile inventions of high value, comparable across countries, the triadic families will be preferred.

107. One can consider more extended patent family definitions. Extended patent family members typically result from complex relationships, having multiple, yet at least one common, priority application from different countries; or relationships resulting from divisions, continuations, or continuations-in-part as in the USPTO case (see Figure 4.1 for an example):

- Divisional application: Results when the applicant splits the initial application into divisional applications, each claiming a different invention included in the initial application.
- Continuations: Result from a second or subsequent application being filed while the original application is pending. At the USPTO, continuation-in-part (CIP) results from a second or subsequent application being filed, which includes new material protected, while the original application is pending.

Box 4.1. Methodologies for nowcasting

Different methods for nowcasting patenting have been developed. Each patent data (*e.g.* USPTO, EPO, etc.) has its own specificities, and a single model may not fit the intrinsic structure of the data, especially in terms of trends: stationary, linear, exponential, etc. Various studies have already tackled nowcasting or forecasting issues, testing different approaches for different datasets (EPO, PCT, by country, by industry, etc.). Among those studies, at least three types of estimating procedure were used:

- *Trends analysis* consists of simple extrapolation of the trends over various time periods; autoregressive integrated moving averages models –ARIMA (van Pottelsberghe and Dehon, 2003) ;
- *Transfer models* predict using the transfer of first filings (priority) to the patent office – this requires a good evaluation of first filings (which are partially available because the information has not yet been publicly released); transfer of PCT filings into regional phase (Schmoch, 1999; Dernis 2007) ;
- *Econometric models* predict patenting based on empirical models (knowledge production functions, Hausman *et al.,* 1981) using economic indicators such as R&D expenditures - by sectors, and source of funds; GDP; number of researchers; value added; indicators of technological opportunities (specific changes in certain technologies); indicators based on specific information from patent offices (budget, number of patent examiners, patent fees, etc.); probabilistic models, etc. (van Pottelsberghe and Dehon, 2003).

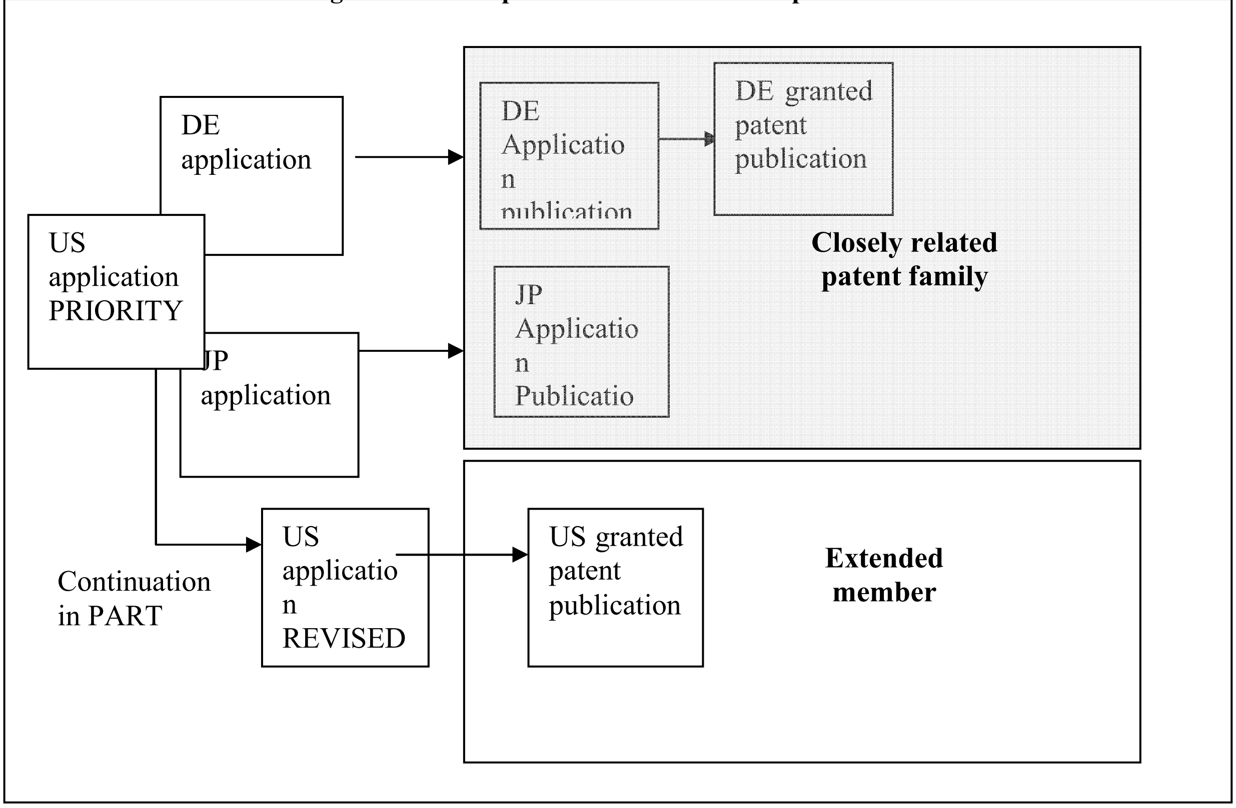
Box 4.2. Nowcasting methods

One way to nowcast patent filings is to predict future applications based on the transfer of previous years. For instance, a two-step procedure to nowcast EPO filings consists first in estimating the number of Euro-PCT filings that entered the EPO regional phase in year *t-2* (Schmoch, 1999; Dernis, 2007). Then, estimations of Euro-PCT at regional phase are added up to the number of direct EPO filings to get an estimate of total EPO filings with a priority in year *t-2*. A second step will evaluate the number of EPO Direct filings and Euro-PCT at international phase for priority date *t-1*, using partial *t-1* data, before re-conducting the nowcasting methodology set up in step 1. A simple arithmetic method can be implemented, using for instance year *t-1* or average *{t-1, t-2}* Euro-PCT transfer rates as an estimate of Euro-PCT transfer rates (*EPCT_TR*) in year *t* :

$$EPCT\_TR_t \approx \frac{EPCT_{t-1}}{PCT_{t-1}} \text{ or } EPCT\_TR_t \approx \frac{(EPCT_{t-1} + EPCT_{t-2})}{(PCT_{t-1} + PCT_{t-2})}$$

where $EPCT_t$ stands for Euro-PCT at regional phase in year *t*; and PCT_t the number of PCT designating the EPO in year *t*. Simple linear models can be estimated to obtain predictions on the Euro-PCT transfer rate in year *t* as a function of either Euro-PCT transfer rate in year *t-1* or of the average transfer rate of the two former years. Additional variables can be added to the models, for instance the growth of PCT filings between *t* and *t-1*. These methods provide robust estimates up to year *t-2* even though patenting activity of small patenting countries or emerging economies are difficult to predict, in terms of both level and growth (Dernis, 2007). Patenting trends have been found more erratic for smaller patenting countries and certain emerging countries/economies (Khan and Dernis, 2005). It is recommended therefore to be careful when applying these approaches to these countries.

Figure 4.1. Example of close and extended patent families



Box 4.3. Other definitions of patent families

In the patent practice, several definitions are used for a patent family to establish a relationship between a patent document and its priority document or priority documents as mentioned by the Paris Convention. Three definitions of patent families will be described here, based on the following example:

Document D1	Priority P1		
Document D2	Priority P1	Priority P2	
Document D3	Priority P1	Priority P2	
Document D4		Priority P2	Priority P3
Document D5			Priority P3

Definition 1: All the documents which are directly or indirectly linked via a priority document belong to the same patent family. This is the definition used by INPADOC. In this case, the documents D1 to D5 belong to the same patent family P1.

Family P1			
Document D1	Priority P1		
Document D2	Priority P1	Priority P2	
Document D3	Priority P1	Priority P2	
Document D4		Priority P2	Priority P3
Document D5			Priority P3

Definition 2: All the documents having at least one priority in common belong to the same patent family. This is the definition used by esp@cenet to obtain the list of family documents by entering the priority number in the appropriate field in the search form. This will result in the display of the list of family documents (the “hit list”). In this case, documents D1, D2 and D3 belong to family P1, documents D2, D3 and D4 to family P2 and the documents D4 and D5 belong to family P3.

	Family P1	**Family P2**	**Family P3**
Document D1	Priority P1		
Document D2	Priority P1	Priority P2	
Document D3	Priority P1	Priority P2	
Document D4		Priority P2	Priority P3
Document D5			Priority P3

Definition 3: All the documents having exactly the same priority or priorities in combination, belong to the same patent family. This is the definition used by esp@cenet to select the reference document for display in the "document view" from a list of family documents mentioned in the results list (hit-list). In this case, document D1 belongs only to family P1, documents D2 and D3 belong to family P1-P2, document D4 belongs only to family P2-P3, and document D5 belongs only to family P3.

Document D1	Priority P1			**Family P1**
Document D2	Priority P1	Priority P2		**Family P1-P2**
Document D3	Priority P1	Priority P2		**Family P1-P2**
Document D4		Priority P2	Priority P3	Family P2-P3
Document D5			Priority P3	**Family P3**

Notes: After a search, all the documents listed in the hit list shall be displayed individually in order to be sure that no information is missed. Only displaying the first document of the hit list is not enough in most of the cases.

Definition 1 corresponds to Inpadoc families. Definition 2 corresponds to esp@cenet families. Definition 3 corresponds to esp@cenet equivalents.

Source: European Patent Office.

Table 4.1. Country shares in EPO applications with various criteria of attribution

	Priority country		Inventor country		Applicant country	
	1990-02	2000-02	1990-02	2000-02	1990-02	2000-02
Australia	0.80	0.63	1.06	1.27	0.99	1.16
Austria	0.73	0.87	1.02	0.99	0.95	0.82
Belgium	0.16	0.38	0.96	1.00	0.76	0.82
Canada	0.33	0.20	1.20	1.86	1.12	1.69
Czech Republic	0.05	0.04	0.05	0.08	0.04	0.06
Denmark	0.62	0.52	0.71	0.82	0.72	0.78
Finland	0.89	0.74	0.90	1.20	0.88	1.42
France	6.18	8.07	7.70	5.89	7.49	5.70
Germany	19.91	19.40	17.93	17.21	17.64	16.79
Greece	0.05	0.03	0.06	0.06	0.05	0.05
Hungary	0.07	0.09	0.14	0.13	0.12	0.10
Iceland	0.02	0.01	0.01	0.03	0.01	0.03
Ireland	0.11	0.08	0.13	0.22	0.13	0.25
Italy	2.84	3.52	3.51	3.18	3.26	2.84
Japan	19.56	20.37	18.16	16.69	18.00	16.63
Korea	1.59	0.27	0.29	2.22	0.30	2.22
Luxembourg	0.05	0.05	0.05	0.06	0.10	0.12
Mexico	0.01	0.01	0.02	0.09	0.02	0.07
Netherlands	0.80	1.43	2.32	2.84	2.93	3.44
New Zealand	0.14	0.07	0.12	0.23	0.11	0.21
Norway	0.26	0.22	0.36	0.43	0.37	0.39
Poland	0.05	0.02	0.04	0.10	0.02	0.08
Portugal	0.02	0.01	0.02	0.04	0.01	0.04
Slovak Republic	0.01	0.00	0.00	0.02	0.00	0.02
Spain	0.52	0.39	0.50	0.80	0.45	0.66
Sweden	1.64	1.60	1.85	2.01	1.83	2.28
Switzerland	0.73	2.28	2.60	2.12	3.17	2.95
Turkey	0.03	0.00	0.00	0.07	0.00	0.06
United Kingdom	5.72	6.85	6.32	5.21	5.71	4.34
United States	36.13	31.87	31.98	33.14	32.80	33.99
OECD	100.00	100.00	100.00	100.00	100.00	100.00

Note: Patent counts are based on priority date and fractional counts.
*Source:*OECD, Patent Database, June 2007.

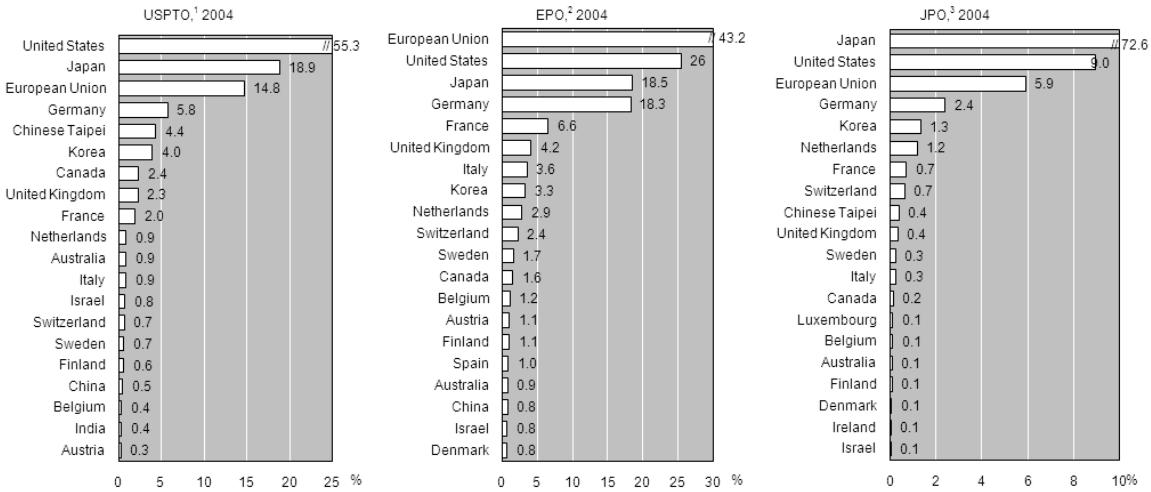
Table 4.2. Differences in patent counts (EPO) depending on the reference selected, 2000

	Number of Patents				Shares in OECD			
Reference	Grants		Applications		Grants		Applications	
	Priority	Grant	Priority	Applic.	Priority	Grant	Priority	Applic.
Australia	103	146	1850	1706	0.33	0.54	1.26	1.27
Austria	554	264	1393	1257	1.78	0.97	0.95	0.94
Belgium	404	321	1490	1470	1.29	1.18	1.02	1.09
Canada	394	308	2609	2353	1.26	1.13	1.78	1.75
Czech Republic	27	7	107	123	0.09	0.03	0.07	0.09
Denmark	312	199	1196	1051	1.00	0.73	0.82	0.78
Finland	385	272	1814	1755	1.23	1.00	1.24	1.31
France	2601	2170	8439	8184	8.33	8.00	5.77	6.09
Germany	9057	5585	25221	24409	29.02	20.58	17.25	18.16
Greece	10	8	74	62	0.03	0.03	0.05	0.05
Hungary	41	22	207	177	0.13	0.08	0.14	0.13
Iceland	7	3	43	41	0.02	0.01	0.03	0.03
Ireland	52	33	288	322	0.17	0.12	0.20	0.24
Italy	1559	1025	4493	4303	5.00	3.78	3.07	3.20
Japan	4989	5497	24432	20909	15.98	20.26	16.71	15.56
Korea	270	163	2620	1985	0.86	0.60	1.79	1.48
Luxembourg	39	17	102	84	0.12	0.06	0.07	0.06
Mexico	7	6	103	103	0.02	0.02	0.07	0.08
Netherlands	839	749	3908	3474	2.69	2.76	2.67	2.58
New Zealand	30	23	337	275	0.10	0.08	0.23	0.20
Norway	139	101	640	565	0.44	0.37	0.44	0.42
Poland	16	10	121	106	0.05	0.04	0.08	0.08
Portugal	14	5	59	38	0.04	0.02	0.04	0.03
Slovak Republic	3	3	39	34	0.01	0.01	0.03	0.03
Spain	305	155	1058	963	0.98	0.57	0.72	0.72
Sweden	666	556	3269	3101	2.13	2.05	2.24	2.31
Switzerland	1005	832	3081	2887	3.22	3.07	2.11	2.15
Turkey	13	3	90	74	0.04	0.01	0.06	0.06
United Kingdom	1653	1582	7769	7320	5.30	5.83	5.31	5.45
United States	5718	7074	49389	45278	18.32	26.07	33.77	33.69
OECD	31210	27139	146242	134410	100.00	100.00	100.00	100.00

Note: Patent counts are based on inventor country and fractional counts.

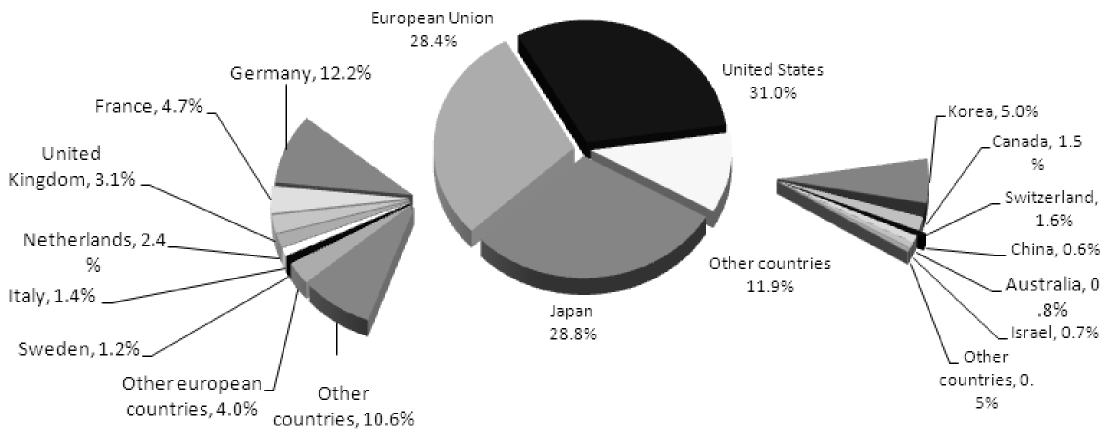
*Source :*OECD, Patent Database, June 2007.

Figure 4.1. Share of countries in patents taken at the three major regions, 2004



1. Patent applications to the USPTO. Patent counts are based on the first-named inventor's country of residence and the application date.
2. Patent applications to the EPO, including Euro-Direct and Euro-PCT regional phase. Patent counts are based on the priority date, the inventor's country of residence and fractional counts. Figures for 2004 and 2005 are estimates.
3. Patent applications to the JPO. Patent counts are based on the applicant's country of residence and the application date, fractional counts. Figures for 2001 to 2005 are estimates based on JPO annual reports.
Sources: USPTO patent statistics reports; OECD, Patent database, June 2007; IIP Patent Database, 2005 and JPO annual reports.

Figure 4.2. Share of countries in total triadic patent families[1] 2004



Notes: Patent counts are based on the earliest priority date, the inventor's country of residence and fractional counts. Data mainly derives from EPO Worldwide Statistical Patent Database (April 2007).
1. Patents all applied for at the EPO, USPTO and JPO. Figures from 1998 onwards are estimates.
Source: OECD, Patent Database, June 2007.

Figure 4.3. Share of countries in patents filed under the PCT procedure,[1] 2004

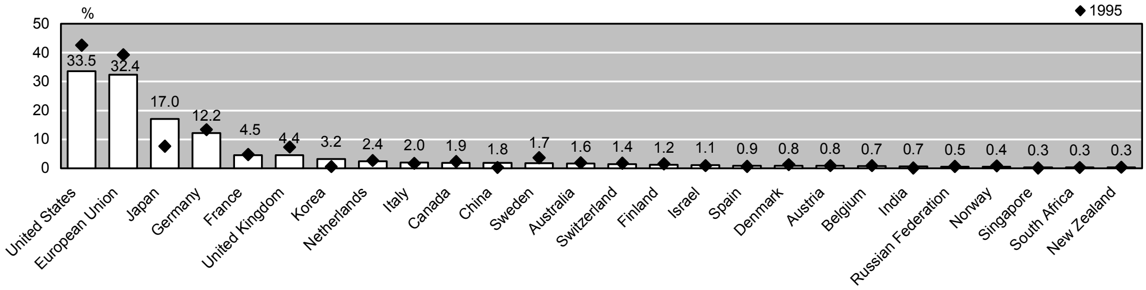
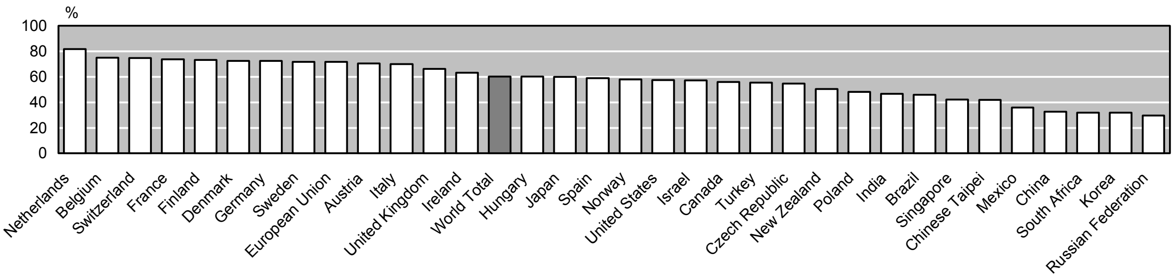
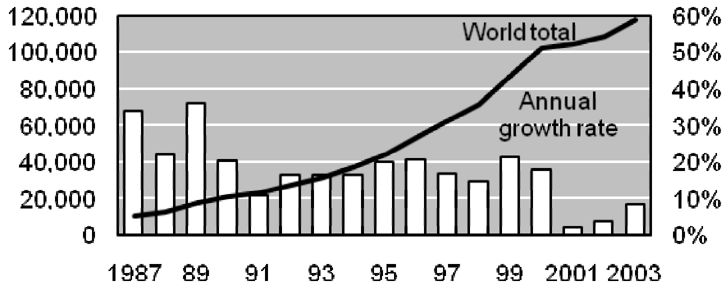


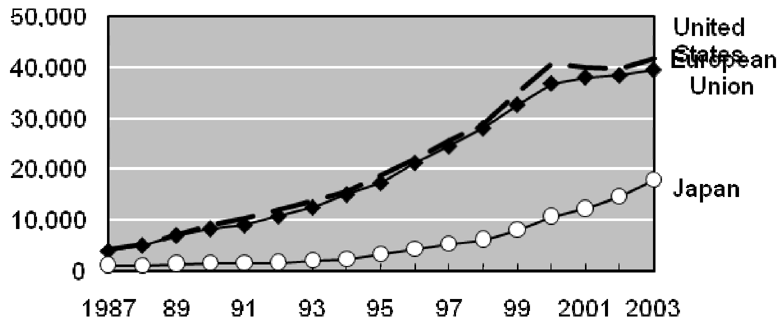
Figure 4.4. Share of Euro-PCT applications entering the regional phase,[2] 2002-04



Note: Patent counts are based on the priority date, the inventor's country of residence and fractional counts.
1. Patent applications filed under the PCT, at international phase, designating the EPO.
2. The graph only covers countries with more than 250 patents filed under PCT for the period 2002-04.
Source: OECD, Patent database, June 2007.

Figure 4.5. Patents applied for under the PCT procedure,[1] EPO designations
Total number, growth rate and major regions





Note: Patent counts are based on the priority date, the inventor's country of residence and fractional counts.
1. Patent applications filed under the PCT, at international phase, designating the EPO.
Source: OECD, Patent database, June 2007.

CHAPTER 5

CLASSIFYING PATENTS BY DIFFERENT CRITERIA

5.1 Introduction

108. Many uses of patent data in research and policy analysis require relating them to a meaningful unit of analysis or classifying them according to particular criteria. By relating or classifying patents in this manner, information can be revealed on these specific units or on the economic or social relevance of certain variables. Analysis could require that patents be related to the entity which filed them, to the individual who made the underlying invention, to a particular field of technology, a particular industry, a particular region or a particular institutional sector.

109. This information is not, however, provided in patent data in a way that allows for its immediate use. It has to be derived on the basis of the available information. This is done by "cleaning" the data (correcting mistakes and standardising the presentation) and by matching them to other data sources, such as lists of companies, lists of technology fields or concordance tables (between technology codes and industries, between city names and regions, etc.). These data sources will permit, in turn, the connection of the information contained in patents with complementary information. This work requires first to identify and then carefully process the data provided in patent files. This is usually difficult and computer-intensive work.

110. This chapter summarises the main classifications used for patents – patents by technology field, industry, regions and institutional sectors – and briefly describes the methodological approaches commonly implemented for their development. General procedures for patent data matching to companies and consolidation by inventor are also exposed. These guidelines can serve as building blocks for future improvements in the area.

5.2 Technology fields

111. As patents cover mainly technical inventions, they are a natural source of data regarding technical change. In many cases, patents are the only reliable sources of data. It is the case notably when one wants to investigate new, emerging technical fields, which are not yet stabilised (*e.g.* when there is not yet an operational definition), not covered by business surveys, etc.

112. Because of their broad and long-term coverage, patent data are useful to examine how technologies behave over time, to identify technology breakthroughs, cross-fertilisation between fields, etc.

An example is provided in Figure 5.1 for patents related to fuel cells technology since the early 1990s. In the analysis of technology development, patent data have been used for studies investigating issues such as:

- New technical fields (emergence and evolution): *e.g.* polymer-based semiconductors, wind energy technologies, etc.
- Technology life cycles (maturity of technology): *e.g.* by tracking annual growth rates of patenting over long periods of time to verify if there is a reduction in the rate of new breakthrough advances (mature technologies: farming, motor vehicles, etc.)
- Cross-technology fertilisation (how one technology influences others): *e.g.* the influence of plasma technologies in electronics (new generations of chips), environmental technologies (plasma lamps), etc.

113. Patent documents contain several types of information which can be used for classifying patents in particular fields: a technical class code and textual information (title, abstract, claims and description). Sometimes other information is used, like the applicant or references.

5.1.1 The IPC Classification system

114. To ease the search of prior art, patent offices classify patents according to their subject matter. These codes are reported in the front page of a patent. These classifications have been constructed from a technical point of view with the intent of retrieving patent documents which reflect the state of the art in a particular field.

115. In view of the international dissemination of patent information, a common international system has proved to be useful. The International Patent Classification (IPC) system grew out of the Strasbourg Agreement of 1971 as an internationally acknowledged method of classifying patents for inventions, including published patent applications, utility models and utility certificates. Currently the IPC is used in more than 100 countries as the major or, in some instances, the only form of classifying these documents. The purpose of the IPC system is to group patent documents according to the technical field in which they lie, independent of both language and terminology.

116. According to the IPC Guide (8th edition, 2006), an invention is assigned to an IPC class by its function or intrinsic nature, or by its field of application. The IPC is therefore a combined function-application classification system in which the application takes precedence. A patent may contain several technical objects and therefore be designated to several IPC-classes. The IPC codes are published on the patent documents.[38] The IPC system is periodically reviewed in order to improve the system and take into account technical and electronic developments. If necessary, the IPC is amended. Prior to 2006 the amendments were not made retroactively, which can raise difficulties for studies using past series. As of April 2007, over 140 million IPC8 classifications have been applied, with approximately 92% of this total having been retroactively applied to documents published prior to the date IPC8 entered into force. The subgroups are hierarchical. The level of subgroup is indicated by the number of dots preceding the title. In the IPC 8th edition, the core and advanced levels are introduced (see Table 5.1 for an example).

38 The IPC is structured into sections, classes, subclasses, main groups and subgroups. The IPC divides patentable technology into eight key areas (A: Human Necessities; B: Performing Operations, Transporting; C: Chemistry, Metallurgy; D: Textiles, Paper; E: Fixed Constructions; F: Mechanical Engineering, Lighting, Heating, Weapons; G: Physics; H: Electricity). Within these areas technology is divided and subdivided to a detailed level, which allows the subject matter of a patent specification to be very thoroughly classified.

117. The EPO works with the ECLA (European Classification System), which is essentially a refined version of the IPC (140 000 categories instead of 70 000 for the IPC). The USPTO uses the US patent classification (USPC). The USPC contains over 160 000 subdivisions. A fundamental principle of the USPC System is that each class is created by first analysing the claimed disclosures of the US patents and then creating various divisions and subdivisions on the basis of that analysis. All similar subject matter is gathered together in large groupings to create classes. These classes are then subdivided into smaller searchable units called subclasses. In term of depth of classification, USPC usually gives more information of what the invention is than the IPC. The first-listed USPC for a patent is hierarchical and is its primary classification, assigned according to a well defined set of classification rules.

118. In addition to the IPC, the Japan Patent Office (JPO) implements an additional classification system, the FI (file index) classification and the F-term (file-forming term) system. The FI classification is an extension of the IPC and is similar to the ECLA. It consists of an IPC subgroup followed by a three-digit number called "IPC subdivision symbol" and/or by one alphabetical letter called "file discrimination symbol". IPC-subdivision symbols and file discrimination symbols are unique to the FI classes and are structured hierarchically. The F-term system works from multiple viewpoints, contrary to the IPC which classifies documents mostly from a single technical viewpoint. Each technical field determined by the range of FI, which is called "theme"[39], has a unique F-term list structure, containing various multiple viewpoints subdivided by many F-term list structure, containing various multiple viewpoints subdivided by many F-terms. Usually a plurality of F-terms is assigned as a set to each patent document. Both indexes are assigned by the patent examiners of the JPO.

119. One patent document can contain one or several IPC codes. In the case of EPO IPC codes are not hierarchised, *i.e.* the first one is not more important or more relevant than the other ones. In the case of JPO, the first IPC code is the main code (indicating technology class), or it is identified with the number one (1). Patent classes are attributed by examiners; when entering the patent procedure, an application is usually pre-classified (using both manual analysis and specialised software), so as to be channels towards the correct examination unit. Then it is attributed to an examiner, who might refine, modify or complement the list of codes of the application. Fractional counting can be used to count patents by IPC classes (or technology areas: groups of IPC classes).

5.1.2 The identification of technological fields

120. The information provided by the IPC constitutes a first reference for identifying patents in a specific technical domain. It is not enough, however, for all uses of the data, since analytical or policy interest are not factors assigned or easily identifiable in patent classifications. This is the case, for instance, of ICT (information and communication technology), biotechnology, nanotechnology, etc. Such aggregates have to be reconstructed, on the basis of the available information: the IPC code or the textual data available.

121. The first step for doing so is to have a clear and operational definition of the technical field of interest. This description will be complemented by keywords, which reflect the contents of the field and which are used by engineers working in the field. The definition and keywords might evolve over time, as the technology is changing fast. On that basis, one can proceed in different ways:

- Searching for such keywords in the definitions of IPC (or other technical classification) codes, and consider as patents belonging to the field all documents which belong to one of the selected codes;
- Searching for keywords directly in the text of patents (or the title, the abstract, etc.);

[39] F-terms do not exist for all Japanese documents; its coverage depends on the field of technology.

- Adopting a mixed solution, looking for keywords in IPC codes, checking manually the relevance of the results, etc. An analyst should confirm that a resulting set of documents identified by these methods truly meets the intended criteria of the desired sample of patents.

122. For instance, in the EPO, the identification of nanotechnology patents involved a series of steps. First, a nanotechnology working group (NTWG) was created in 2003. At the beginning, it worked on the definition of nanotechnology in order to watch trends in nanotechnology patents. Then the NTWG identified nanotechnology patents through keyword searches, consultations with nanotechnology experts in the EPO, and peer reviews by external experts. Patent applications from 15 countries or organisations were analysed and tagged to class Y01N.[40]

123. The OECD has designed definitions of various technical fields: ICT, biotechnology, space-related technologies, environmental technologies, etc. These definitions consist of *i)* a textual definition of the technical field, and *ii)* a list of associated IPC classes. Reducing a technical field to a list of IPC classes has the advantage of simplicity of use (it suffices to identify the IPC code of a patent to attribute it to the relevant field). On the other hand, it does not allow discriminating within IPC codes, which increases the risk of misusing relevant documents or including irrelevant ones. The Y01N code for nanotechnology, which is attributed partly by examiners on an *ad hoc* basis avoids such a drawback, but in view of its cost could not be extended to many other fields. Figure 5.1 displays trends in patenting related to fuel cells technology and Figure 5.2 reports the share of countries in this technological domain. As mentioned before, patents provide information that permits to track very specific technology areas at a very refined level. Figure 5.3 shows the share of related techniques (identified according to the main IPC code) in fuel cells patents.

124. A partition of technical fields has been proposed by OST-INPI/FhG-ISI *(Observatoire des Sciences et Technologies, Institut National de la Propriété Intellectuelle)* and the Fraunhofer Institute for Systems and Innovation Research). It consists of a list of 30 technical categories, which are groupings of IPC subclasses, which cover the entire IPC classification. As compared with the IPC itself, this grouping is closer to the concerns of policy-oriented analysis.

5.1.3 The sectoral specialisation of countries

125. The identification of technology domains and industries in patent data permits to analyse the relative technological position of a country relative to others or to the world average. More spefically, the sectoral structure of countries' patenting activity can be investigated using patent indicators of specialisation (Soete and Wyatt, 1983). The most frequently used indicator is called the "specialisation index" " or "Revealed Technological Advantage" (RTA) index and is defined as the share of a country (*i*) in patents in a particular field of technology (*d*) divided by the country's share in all patents:[41]

$$RTA = \frac{\left(P_{d,i} / \sum_{d} P_{d,i} \right)}{\left(\sum_{di} P_{d,i} / \sum_{d,i} P_{d,i} \right)}$$

40 The Y code is a "parallel tag". This means that an application can be in almost any technical IPC class area, but if the size is small so that it is nano, it gets a Y code. The EPO definition of nanotechnology is the following: *"The term nanotechnology covers entities with a controlled geometrical size of at least one functional component below 100nm in one or more dimensions susceptible to make physical, chemical or biological effects available which are intrinsic to that size. It covers equipment and methods for controlled analysis, manipulation, processing, fabrication or measurement with a precision below 100nm."*

41 The RTA index can be applied not only relative to world sectoral distribution but also to other comparison groups (*e.g.* compared to national or regional distribution)

126. The index is equal to zero when the country holds no patents in a given sector, is equal to 1 when the country's share in the sector is equal to its share in all fields (no specialisation), and grows rapidly (the upper limit will depend on the world distribution being used) when a positive specialisation is found. The logarithm of the index can be used to obtain a new indicator with a distribution ranging from -1 to +1.

127. Specialisation indicators can be calculated for different periods, to show how countries' specialisation patterns have evolved over time. It should be remembered, however, that such indicators are relative to the world sectoral distribution of patents; if one country holds its distribution of patents steady while others increase their activity in an emerging field, its specialisation index in that field will decline. Figure 5.4 displays the specialisation index in biotechnology patenting for countries with more than 200 EPO applications for the period 1996-2002.

5.2 Industry classification

128. Patents can be used as indicators of the output of R&D, or inputs to innovation at the industry level. However, patent data cannot be directly attributed to particular industries, as patent documents do not include explicitly the relevant information permitting to identify the economic sector to which the technology embodied in the patent is associated. The association of patents to industries allows patent data to be matched with other industry data, such as the OECD STAN database. It makes it possible to analyse important policy issues, for example:

- Measuring the inventiveness of industries: estimating knowledge production functions at industry level, with inputs (notably R&D) on the right hand side, outputs (patent-based indicators) on the left-hand side (*e.g.* Pavitt, 1984; Ulku, 2007)
- The industry specialisation of countries, in connection with trade and production specialisation (*e.g.* Dosi *et al.*, 1990; Malerba and Montobio, 2003).
- Cross-industry technology transfers (using *e.g.* patent citations associated with the source and the recipient industries).

129. The attribution of patents to industries can be made in the following ways:

- Direct attribution, by *ad hoc* examination of the patent.
- Attribution to the patent of the industry code of its applicant (company).
- Establishing *a priori* (with experts) a correspondence between IPC classes and industries, and integrating it into a concordance table.

130. In certain cases a mix of the different methods has been used to maximise the quantity of information integrated in the process.

131. Several methods have been developed over the last two decades. As explained by Schmoch *et al.* (2003), a reliable concordance should meet the following conditions: *i)* international comparability – they should be adaptable to other industry classifications; *ii)* adequate level of desegregation – permitting backward decomposition of industries to technology fields; *iii)* strong empirical basis – they should be consistent with trends in technological and production activity of countries; and *iv)* easy applicability to specific problems.

132. The designation of industry affiliation to patents can be done under two different criteria: *i)* patents can be allocated to the industrial sector of origin (to the main economic sector of the inventing/applicant company), *ii)* or to the sector of use (to the main industry the product incorporating the invention belongs).

133. Nearly all available concordance tables have taken the first approach. The computation of these classifications encounters, however, numerous difficulties as not all inventions can be allocated to a sector or, as in most of the cases, they can be pertinent to different industries at the same time. The classification by main economic activity of companies presents problems as well; large firms in particular patent in a variety of fields which do not necessarily correspond to their main economic activity. For small companies, which are more specialised, their field of activity might not be accessible from any database. As patent and industrial classification change over time, the concordance tables need to be updated on a regular basis.

134. An early attempt to build an industry concordance table for patents was the *"Yale Concordance"* developed by Evenson, Putnam and Kortum (1991) on the basis of the industry classification implemented by the Canadian Intellectual Property Office (CIPO). Between 1972 and 1995, examiners from the CIPO assigned IPC codes along with an industry of manufacture (IOM) and sector of use (SOU) code to each of over 300 000 granted patents.

135. Another attempt was the *"OTAF Concordance",* the USPTO concordance between the US Patent Classification system (USPC) and the US Standard Industrial Classification System (SIC), created in 1974. It relies on a manual review and mapping of classification categories in the USPC, which are associated with a limited set of industry-based product fields based on 1972 SIC. These are high-level SIC classifications that are generally at the two to three-digit SIC level (41 industrial sectors). It is based on the industry of manufacture and is updated on a regular basis, generally annually, to accommodate changes and revisions that are made to the USPC each year. Efforts are being made to update this concordance to the recently adopted North American Industry Classification System (NAICS). Other works in this field include the concordance proposed by Johnson (2002) based on data from the Canadian Patent Office. This includes linkages of technologies, based on probabilities of matching, to about 115 sectors of manufacture and use.

136. A more recent concordance table has been designed by Schmoch *et al*. (2003) from the Fraunhofer Institute for Systems and Innovation Research, the *Observatoire des Sciences et des Techniques* (OST) and the University of Sussex, Science and Policy Research Unit (SPRU). They rely on the economic activity of companies to classify technologies into industries.[42] Their methodology involved four steps. First, a set of industrial sectors, defined by NACE and ISIC codes (two-digit level) was selected as a basis. Second, technical experts associated 625 IPC subclasses to technological categories (44 fields) and industrial categories according to the manufacturing characteristics of products. Third, the technical and industrial approaches were compared by investigating patent activities by technology-based fields of 3 400 large patenting firms classified by industrial sector (44 industrial sectors). This computation led to the elaboration of a transfer matrix or concordance between technology and industry classifications. Fourth, the adequacy and empirical power of the concordance was verified by comparing the resulting country structures (*e.g.* similarities in the distribution of a given technology across and within industries, by country and over time). This table was sponsored by Eurostat. It is used by the OECD for the ANPAT database, the patent segment of the STAN database (which also includes databases of value added, employment, R&D, etc., at industry level for 20 industries, starting in 1971).

137. Based on this concordance, Figure 5.5 displays the relationship between patenting and R&D expenditure (OECD averages) for manufacturing industries. High R&D-intensive industries, such as pharmaceuticals or medical, precision and optical instruments are among those that patent the most. Inversely, weaker technological activity, in terms both of R&D and patenting, is frequently found in textiles, leather and wood and paper-related industries.

42 Other decisions in generating the concordance matrix are: only large patents are included, only manufacturing companies are considered, only the "principal" product group of a firm is considered (although some large companies are multi-product) and only first IPC class is considered.

5.3. Regional classification

138. Describing and understanding regional patterns of innovation is important both for regional and national policy makers for regional policy makers as it provides them with benchmarks and references; for national policy makers as it captures an important dimension of the national innovation policies. Attributing patents to regions allows one to address important policy questions (non-exhaustive) such as:

- The comparative technological performance and profile of regions.
- The importance of geographical proximity for innovation (Jaffe *et al.*, 1993; Audretsch and Feldman, 1996).
- The analysis of spatial distribution (or concentration) of innovative and productive activity across regions (*e.g.* Paci and Usai, 2000)
- Interactions and technological cooperation within regions and across regions (*e.g.* Breschi and Lissoni, 2001)

139. Information provided in the front page of a patent includes the address of the inventors and applicants. This information, which includes, city, region, and postal (ZIP) code, permits to link patents to a particular region (of the inventor or of the applicant) based on lookup tables (postal codes, city names, etc.). Regionalisation of patent information depends on the details (and quality of information) given in the address. This information is not always consistent across patent offices, and is not very detailed in some countries. As the information is often partial, or sometimes missing, sophisticated algorithms have to be run, which identify the relevant information and match it to information given in specialised regional databases. For instance, USPTO patents usually do not include the ZIP code of the inventor, but only the city name and (not always) the state code.[43] For regionalising such patents the city name should be used, while recognising that difficulties such as several cities having the same name, the street name corresponding to a city, etc., need to be dealt with.

140. Regions are defined in standard ways. The OECD uses the TL ("territorial levels") classification, which has different levels of aggregation (level 2 consists of about 300 macro-regions; level 3 consists of 2 300 regions, *e.g.* the US BEA economic areas, Japanese prefectures, French "départements"). In EU countries, regions are defined by NUTS (*Nomenclature des Unités Territoriales Stastisques)*, an official classification of the European Commission. The OECD has compiled databases of patents (PCT, EPO) at TL3 level (see OECD, 2008).[44] An example of top patenting regions in ICT technologies is provided in Figure 5.6.

141. When using regionalised patent data, two particular issues need to be kept in mind. First, regarding inventors, one has to be careful not to go to a too detailed level in certain large urban areas. The inventor might live in a different area code than the laboratory s/he works in (it will be then in a neighbouring area). Several co-inventors of the same invention might live in different zones of the same (large) city while they work at the same place. Hence, for large urban areas, made of several detailed sub-areas it can be better to work data at a more aggregated level (*e.g.* level 2 instead of level 3). That can apply, in Europe, to the Paris or London areas, for instance. Second, a patent application may be filed by an affiliate of a firm, or co-filed by the firm and one of its affiliates. The address of the affiliate will appear

43 Addresses provided in EPO patents are more complete than those of USPTO and PCT (WO): in most cases, both the town name and the postal codes are available in the address field of EPO patents. In USPTO patents, the postal codes are often missing and the regionalisation process is mostly based on town names.

44 The data sources of the Regional Patent Database (OECD) are EPO's Worldwide Statistical Patent database (PATSTAT): extraction of patents taken at the EPO, the USPTO and PCT filings (WO publications); and inventors and applicants records from EPO patents (data extracted from Epoline web services).

in these cases and may not reflect the location of the entity actually controlling the patent. Consolidation of company ownership by groups will solve that problem.

5.4 Institutional sectors

142. The institutional sector of a patent holder is its legal status: it can be an individual, a company (business sector, a government entity, a university or a hospital. The identification of patenting by universities and public institutions (governmental centres of research) permits the examination of issues such as:

- The impact of certain policies on university patenting (*e.g.* the Bayh-Dole Act in the US and similar policies in other countries, see Mowery *et al.*, 2001).
- Patterns in co-operation in research between universities and public research centres and private companies (*e.g.* Cassiman and Veugelers, 2005).

143. Patent data can be matched with other data, like R&D, if the list of institutional sectors for the two data sources is compatible.

144. Methods for allocating institutional categories to patents rely on algorithms designed to identify relevant information from the name field of patents which can provide clues to "sector" membership (see Table 5.1). Such clues can be parts of names, specific words (*e.g.* government) and/or terms singling specific legal forms (*e.g.* Inc.). If such clues can be identified in systematic manner, they can be integrated into one script, which in itself allows for an automated allocation of sector codes.

145. Van Looy *et al.* (2006) have recently developed, for Eurostat, a methodology based on this approach (see Table 5.2). In line with the OECD *Frascati Manual* (2002),[45] this algorithm permits the allocation of patents to: *a)* individuals, *b)* private enterprises, *c)* government, *d)* universities, *e)* hospitals or *f)* private non-profit organisations.[46] Their analytical procedure combines both rule-based and case-based logic. The former works on the assumption that information incorporated in patentee names can provide key words on institutional membership, which can then be translated into a set of rules for the allocation of sector codes. In practice, however, as the authors found out, such as rule-based approach proves to be insufficiently complete and accurate. The absence of clues, as well as the simultaneous presence of several clues that suggest different sectors, is a common feature. In order to remedy this situation, a second, case-based, layer is introduced. Conditionality is introduced to minimise the number of multiple sector assignments.

146. The matching of name characteristics to the different categories is sometimes not clear cut for certain types of organisation. For instance, hospitals could be classified as either 'business enterprise', 'private non-profit' or 'higher education' depending on the governance mode under which they operate. The sector in which a given organisation should be classified is not always clear from looking solely at name field information found in the patent system. To deal with these issues, these authors introduced

45 It should be noted that individual (private) applicants do not show up as a separate category in the Frascati classification; in addition, the "Abroad" category carries little relevance when classifying patentee names. In the OECD *Frascati Manual* (2002), five sectors are identified: *1)* business enterprise, *2)* government, *3)* private non-profit, *4)* higher education, *5)* abroad. Households are considered part of the private non-profit sector.

46 The USPTO uses a classification with seven categories: unassigned (those patents for which the inventors have not yet granted the rights to the invention to a legal entity), and assigned to: US non-government organisations, non-US non-government organisations, US individuals, non-US individuals, the US federal government, and non-US governments.

different types of rules; besides generic ones that relate several patentees to one sector, rules were added targeting specific organisations. This approach is implemented by Eurostat and by OECD.

147. It should be noted that the coverage of university-originated patents by universities as patent applicant is incomplete. Inventions from university researchers are not necessarily patented by the university itself: it could be the researcher, or a company having funded the researcher. Searching this type of inventions requires the identification of university inventors (inventors name and addresses). By a match of inventor to author names (based on lists of researchers) it is possible to show that in many countries about 50% and more of the university-based patents cannot be identified by the applicants (Noyens *et al.*, 2003). Some other strategies are to identify university or related institutions in the addresses of inventors; for some countries this strategy has increased the share of patents coming from universities by around 10%.

5.5 Patents by companies

148. Attributing a patent to particular entities which own them is a key step in many statistical and analytical works using patents. It allows reconstructing the patent portfolio of companies, which is used notably to:

- Compile classifications of patents by industry, technical field, region, institutional sector, etc.
- Analyse the patenting strategy of firms (timing and orientation of their patent filings, in relation with competitors).

149. Matching patent information with other information at the firm level, such as R&D, innovation, stock market value, etc., permits the technology or patenting strategy of companies to be related to other characteristics: What is the impact of patents on market value? What is the efficiency of R&D (in terms of patent numbers)? Etc.

150. The name and address of the patent holder are published in patent documents: however, the attribution of a patent to a particular entity is not so trivial. There can be the usual spelling mistakes; there is also the fact that many companies are known under several different names (*e.g.* acronyms: IBM, International Business Machines); some qualifications can be added to the name (*e.g.* Siemens, Siemens AG); patents can be taken by affiliates, some of which are easily identified (*e.g.* Sony US is an affiliate of Sony), whereas others are more difficult (Citroen is part of the PSA group). It is not unusual for a large group to have an affiliate in charge of managing its intellectual property, and the affiliate files in its own name many of the patents for the group (*e.g.* Philips).

151. Changes in the company’s legal status, as well as changes in company names, affiliations, and mergers and acquisitions make the use of patents imperfect for the analysis of company patenting and questions related to patenting and innovation strategies by companies. For instance, when aiming at legal entity harmonisation, all patents held by Hewlett Packard, Digital Equipment Corporation and Compaq might be considered as belonging to one and the same legal entity; likewise, “ANDERSEN CONSULTING” would become harmonised to “ACCENTURE” (name change).

152. Patent offices do some cleaning and harmonisation of names already. For instance, the USPTO deals with the name of the first applicant to any patent. The EPO attributes a standardised code to patent applicants, as does the JPO for applicants filing electronically. This is not sufficient, however, in addressing the needs of statisticians. The cleaning and harmonisation of names can proceed through several steps (not all necessary, nor exclusive of each other):

- Basic cleaning (standardising words like “Ltd”, “GmbH”, etc.) and standardisation of names.

- Matching the standardised name of applicants with a company database of reference (*e.g.* Amadeus for Europe, Compustat for the US).
- Reconstructing the group structure by using information on the ownership structure (including affiliates) as reported in specialised databases (*e.g.* the "*Who owns whom*" database).

153. The first stage consists of identifying spelling variations in order to clean the names of applicants to obtain a standardised name that can allow to group companies. This is done with the aid of approximate matching techniques. Two approaches are used to group similar names and standardise. The rule-based approaches regard the definition of rules to compare the similarity of names.[47] The second approach relies on the use of dictionaries, which are large collections of names, serving as examples for a specific entity class. Some examples are: USPTO & EPO standard assignee names file; Derwent Patentee Codes. It is also possible to build own dictionaries with a harmonisation procedure (*e.g.* Magerman *et al*, 2006).

154. The second stage is made by linking the standardised names to the names contained in a company database (*e.g.* Amadeus, Compustat, etc.) directly or in combination with other methods to find as many potential matches as possible. For instance, the matching can use other available information about the company (in addition to the name), *e.g.* addresses and searches based on related patentee names of priority patent filings or PCT applications, etc. The matches obtained need to be validated and doubtful matches can only be solved by hand. Lastly, the companies identified can be legally consolidated using information on the ownership structure. Notice though that these two stages, matching and legal consolidation, can also be done at the same time if the company data used already includes information on the legal relationships between companies. However, data on ownership structure are rarely codified over time. As a result, most of the available information records only the most recent legal structure of companies. In consequence, further information is needed to track these changes (*e.g.* mergers and acquisitions) over time and properly separate patenting activity by companies in different periods of time.

155. Major work done in this field includes the NBER database of USPTO patents, harmonised with Compustat (www.nber.org/patents), the KUL algorithms for Eurostat (Magerman *et al.,* 2006), and the work done by Thoma and Torrisi (2007) and Thoma (2008).

5.6 Patents by inventors

156. The proper identification of inventors in patent filings allows the inventive record of the concerned individuals to be reconstructed, and to match this record with complementary data on these individuals available from other databases. There is a wide array of interesting and highly policy-relevant topics that can be investigated with the aid of data on the harmonised names of inventors. For instance:

- The productivity of inventors – over time, across fields, countries, etc. (Hoisl, 2007)
- The mobility of inventors – across cities, regions, countries, sectors (*i.e.* shifts between public and private sectors), and the resulting spillovers of such turnover (Kim *et al.*, 2005; Crespi *et al.*, 2005)
- The networking strategies by inventors – who invents with whom – and their impact on productivity (Singh, 2003; Breschi and Lissoni, 2003)
- Gender issues (share and profile of genders among inventors, see Naldi *et al.*, 2004).

[47] Two examples are the Levenshtein's "Edit Distance", which measures similarity by the number of operations to switch from one word to another; and the Jaccard Similarity Measure, which is token-based and accounts for differences due to the position of the same tokens between otherwise identical strings. Other algorithms - such as Token-based or N-grams, amongst others - often may use jaccard-style indicators for the final computation of similarity.

157. The advance on this matter has been hindered by the difficulties associated to the recording of names in patent data and the complications in recognising “who is who” in the population of inventors contained in patent data. Three fundamental problems have made the information on inventors relatively ineffective for investigation. First, the name of the same inventor can be spelled slightly differently across some of his/her patents (it may be with or without the middle name and/or initial, with or without surname modifiers, etc). Secondly, even if there are two exact names, we cannot know whether the two names correspond to the same person (the “John Smith” problem). In other words, different inventors having exactly the same name may appear in various patents. Third, the transcription into the Latin alphabet of non-western names is imperfect and can create ambiguities (“Li” vs. “Lee”).

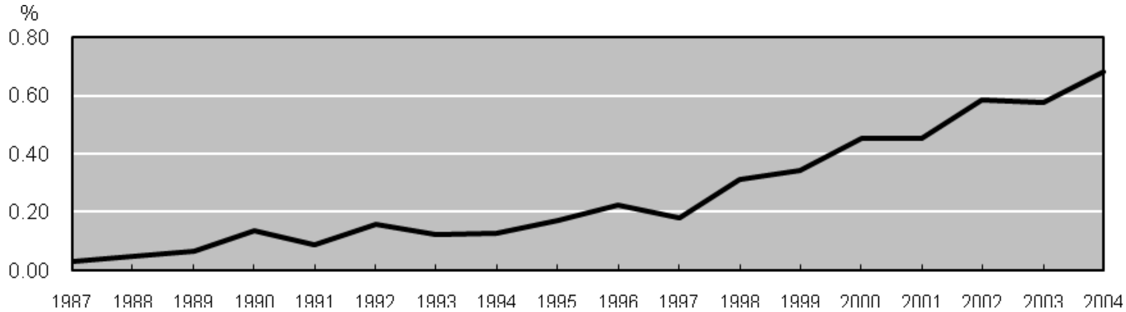
158. Researchers have attempted to harmonise names using computerised matching algorithms applied until now under specific subsets of patent data. For example, the methodology developed by Trajtenberg, Shiff and Melamed (2006), which has been used on the USPTO patent data, can be summarised as follows:

- *Stage 1: grouping similar names.* In order to address the problem of the same inventor being spelled slightly differently from patent to patent, a two-track approach has been used. The first is to “clean up” and standardise the names as much as possible; the second is to complete the list of harmonised names with the aid of the “Soundex system” to encode names with similar pronunciation.[48]
- *Stage 2: comparing names and matching.* To deal with the problem of determining who among the potential “suspects” displaying the same name refer in fact to the same person, names are compared and criteria of matching are imposed. Pair-wise comparisons can be made between any two “suspects” using a series of variables such as middle name, geographic location (*e.g.* postal codes, cities, etc.), the technological area (*i.e.* patent class), the assignee, the identity of the co-inventors, etc. If a data item is the same in two suspected records (*i.e.* if two records display the same address, or are in the same patent class, or share the same partners, etc.), then the pair is assigned a certain score. If the sum of these scores is above a predetermined threshold, the two records are “matched” and they are regarded as being the same inventor.[49]

48 Soundex is a phonetic algorithm for indexing names by sound, as pronounced in English. The goal is for names with the same pronunciation to be encoded to the same representation so that they can be matched despite minor differences in spelling.

49 Once that is done for all the pairs in the comparison set, the condition of transitivity is imposed, *i.e.* if record A is matched to record B, and B to C, then the three are regarded as the same inventor.

Figure 5.1. Trends in patenting of fuel cells,[1] share of patents filed under the PCT,[2] 1987-2004



Note: Patent counts are based on the priority date, the residence of the inventors and fractional counts.
1. Fuel cells patents are identified using IPC classes H01M8/00-8/24, and refer to patent applications filed under the PCT, at international phase, designating the EPO.
Source: OECD, Patent Database, June 2007.

Figure 5.2. Share of countries in fuel cells patents,[2] 1987-2004

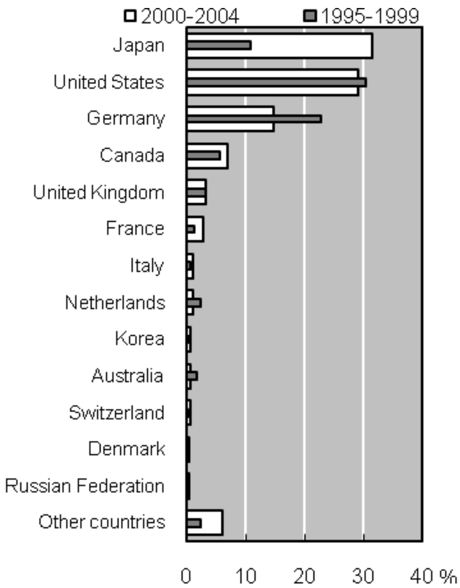
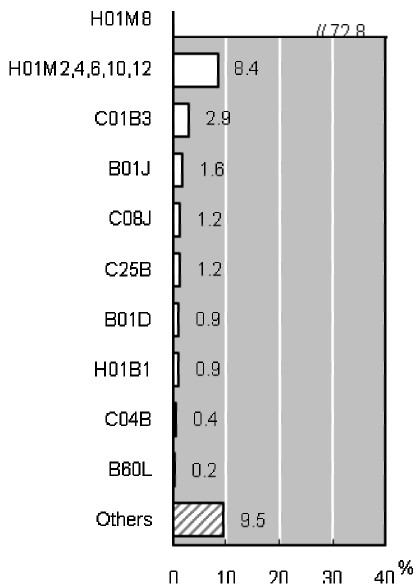
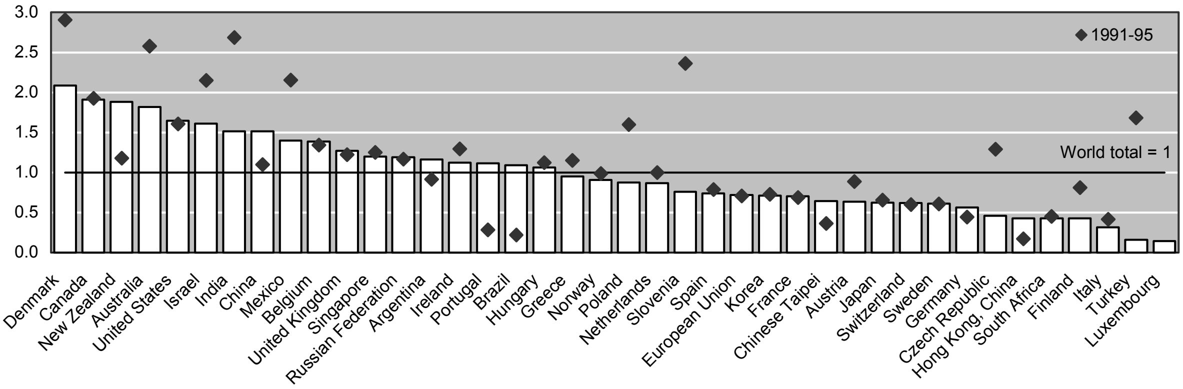


Figure 5.3. Share of related-techniques[1] in fuel cells patents,[2] 1987-2004



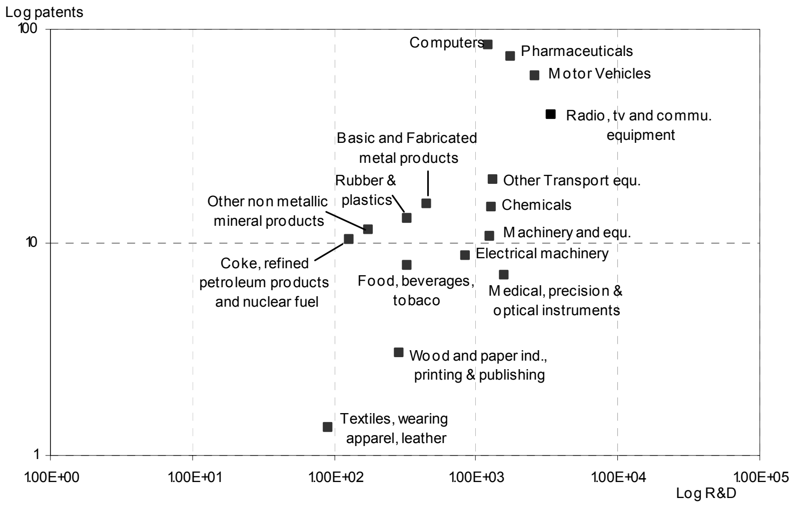
Note: Patent counts are based on the priority date, the residence of the inventors and fractional counts.
1. Fuel cells patents are identified using IPC classes H01M8/00-8/24, and refer to patent applications filed under the PCT, at international phase, designating the EPO.
2. Different techniques were identified according to the main IPC code of fuel cells patent: Separation (B01D); Chemical or physical processes (B01J); Electric equipment or propulsion of electrically-propelled vehicles (B60L); Hydrogen (C01B3); Lime, Magnesia, Slag, Cements (C04B); General processes of compounding (C08J); Electrolytic or electrophoretic processes (C25B); Cables, Conductors, Insulators (H01B1); Batteries - unclassified fuel cells (H01M2,4,6,10,12); Fuel cells (H01M8).
Source: OECD, Patent Database, June 2007.

Figure 5.4. Specialisation index of biotechnology patents[1] filed at the EPO[2], 1996-2002



Note: Patent counts are based on the inventor's country of residence, the priority date and fractional counts.
1. The provisional definition of biotechnology patents is presented in Annex B.
2. The graph only covers countries/economies with more than 200 EPO applications for the period 1996-2002.
Source: OECD, Patent Database, December 2005.

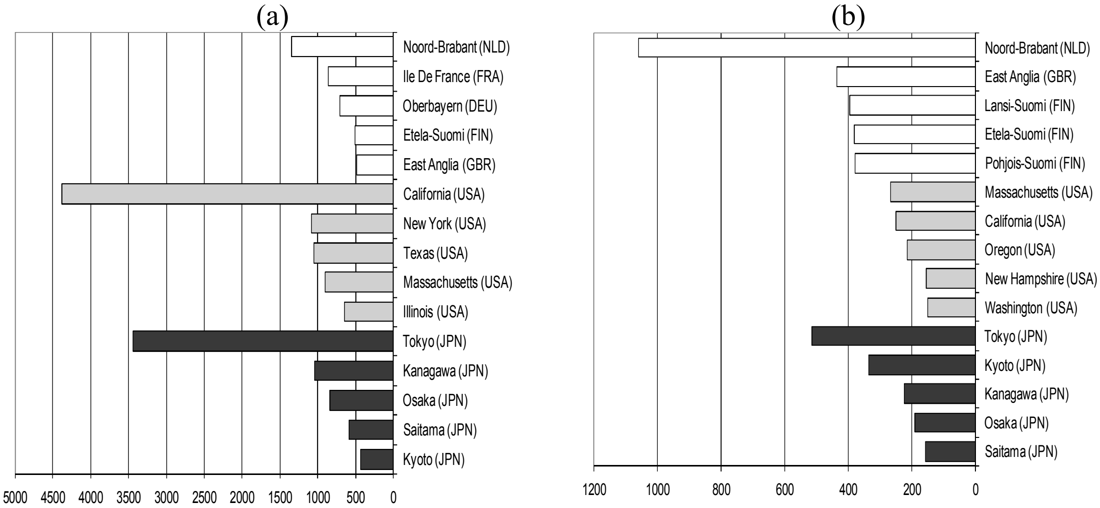
Figure 5.5. Patenting by industry and business R&D,[1,2] PCT filings 2002-04



Note: Patent counts are based on the priority date and fractional counts.
1. Patent applications filed under the Patent Cooperation Treaty, at international phase, designating the European Patent Office.
2. Average business R&D expenditure in 1999-2000, millions of USD (2000) using purchasing power parities and patenting by industry in 2002-04 in OECD countries.
Source: OECD, Patent Database, June 2007.

Figure 5.6. ICT patents by region in Europe, the United States and Japan[1,2,3]

The number of PCT applications (a) and PCT applications per million labour force (b) in 2004



Note: Patent counts are based on the priority date, the inventor's region of residence and fractional counting.

1. Only countries with more than 100 PCT applications in 2004 are included.
2. Countries in which 60% or more inventors' addresses are assigned to regions are included.
3. Only regions with more than 100 PCT applications in 2004 are included. ICT patents are identified by the International Patent Classification (IPC).

Source: OECD, Patent Database, June 2007.

Table 5.1. Main characteristics of IPC codes (example)

Heading name	Heading number	Code letter	Code label
Section	8	G	Physics
Sub-section	20	G0	Instruments
Class	118	G06	Computing Calculating Counting
Subclass	616	G06F	Electrical digital data processing
Main Group	6871	G06F-009/000	Arrangement for program control
Subgroup	57324	606F-009/06	•Using stored programmes
		606F-009/46	••Multi-programming arrangements

Table 5.2. Examples of keywords/clues used to identify patentee sectors

Sector	Keywords
(1) Individual	"*DIPL.-ING.*"; "*PROF.*'; "*DR.*"; "DECEDE*""DECEASED*"; "*DIPL. ING.*"; "*P.HD*'; '*DIPL.-GEOGR.*"; "*ING.*"; '"*EPOUSE"*
(2) Private enterprise	"*SA*"; "*S.R.L.*"; "*HANDESLBOLAGET*"; "*ING.*" ; "*INC*" ; *LTD*"; "*S.A.R.L."* "*BVBA*"; "*S.P.R.L. *" ; "*NAAMLOZE VENNOTSCHAP*"; "*AKTIEBOLAG*"
(3) University	"*UNIVERSI*"; "*UNIV.*"; "*COLLEGE; "*SCHOOL; "*REGENTS*"; "*ECOLE*"; "*FACULTE*"; "*SCHULE*"; "*UNIVERISTY; "*UNIVERSITY*";
(4) Hospital	"*HOSPITAL*"; "*MEDICAL CENTER*"; "*MEDICAL CENTRE*"; "*ZIEKENHUIS*"; "*CLINIQUE*"; "*NOSOCOMOIO*"; "* CLINICA*"; "*POLICLINICA*"; HOPITAL*"; "*HOPITAUX*"
(5) Public and Private Non Profit	"*GOUVERNEMENT*", "*MINISTRO*"; "*INSTIT*"; *ÏNSTYTUT*" ; "*FONDATION*"; "*CHURCH*" ; "*TRUST*"" "*KENKYUSHO* :; "*STIFTUNG*"

Source: Magerman *et al.* (2005)

CHAPTER 6

THE USE AND ANALYSIS OF CITATIONS IN PATENTS

6.1 Introduction

159. The use of patent and non-patent citations as indicators of innovation has proliferated dramatically in the last 10 years. As citations indicate the S&T precedents in inventions, they permit the tracking of knowledge. It is possible to identify the influence of particular inventions or particular sets of inventions and map their diffusion in the economy. In particular, the number of citations a patent receives has been found to reflect on average the technological and commercial importance of a patent, which helps to deal with the problem of heterogeneity in the value of patents.

160. Citations also permit to investigate connections between technologies, between science and technology, or between firms, industries, countries or regions. These linkages can be broken down in a variety of ways: by technical field, by type of entity (*e.g.* multinational or domestic firm, university, etc.), by inventor, etc.

161. This chapter describes the meaning of citations in patents and explain how they can be used to compile S&T indicators. It stresses in particular the issues to take into account when compiling patent citation-based indicators for the analysis of innovation. These guidelines can serve as building blocks for future improvements in the area.

6.2 What are citations?

162. Patent and non-patent citations are the references provided in the search report that are used to assess patentability of an invention and help to define where the claims of the new patent application stand. As they refer to the prior art, they indicate the preceding knowledge to the invention and may be also cited to show the lack of enablement for the invention. However, citations do not only represent knowledge flow from the prior art to the referred invention but also the legal boundaries imposed on the claims of the patent application in question. Hence they serve an important legal function, since they delimit the scope of the property rights awarded by the patent. If a patent B cites patent A, it means that patent A represents a piece of previously existing knowledge upon which patent B builds or to which patent B relates, and over which B cannot have a claim. Hence citations might be used to preclude the issuance of a patent or limit the scope of the protection to precisely what was known the time for filing the patent application.

163. In most of the cases, citations are the product of an extensive search of the state of the art conducted by examiners (resulting in the ‘search report’) aiming to assess the degree of novelty and inventive steps of inventions, necessary for their patentability. Citations can be used to refuse patent applications when the claimed invention seems obsolete after confrontation with the state of the art. The

search includes publicly available scientific or technical documents or any other testimony which constitute a relevant precedent of that invention.

164. There are basically two kinds of citations. Patent references are citations to previous relevant technology protected by or described in other patents filed anywhere in the world, at any time, in any language (see Table 6.2). References categorised as non-patent literature (NPL) are scientific publications, conference proceedings, books, database guides, technical manuals, standards descriptions, etc.

6.3 Uses and applications of citations indicators

165. The potential of patent citation measures for policy analysis is tremendous. Three applications of patent citations dominate the innovation literature: *i)* the measurement of knowledge flows or spillovers (*e.g.* Jaffe *et al.*, 1993), *ii)* the measurement of patent quality (*e.g.* Scherer *et al.*, 2003), and *iii)* the strategic behaviour by companies (*e.g.* Podolny *et al.*, 1996).

166. Backward citations – citations made to previous patent documents – are helpful to track knowledge spillovers in technology. This methodology permits to estimate the curve of obsolescence of technologies, the diffusion of knowledge emanating from specific inventions – institutions, areas or regions, etc. Yet patent and non-patent citations are in some cases a "noisy signal" of knowledge flows, as the inventor of the citing patent is not always aware of the existence of the cited one (*e.g.* Jaffe *et al.*, 2000).[50]

167. Forward citations – patent citations received – can be used to assess the technological impact of inventions, cross-technology and/or geographical impact, etc. The technological impact of inventions can reflect the economic importance of patents. Correlation has been found repeatedly between the value of a patent and the number and quality of its forward citations. Citation weighted indicators (*e.g.* patent stocks of companies), have been found to have a close relationship to economic indicators (market value of companies). It has been consistently reported that patents that receive more citations than the average are more likely to be renewed (Lanjouw *et al.,*1998) and opposed or litigated in tribunals (Lanjouw and Schankerman, 1997; Harhoff *et al*, 2002).

6.4. Citation practices in patent offices

168. **Citation practices differ across patent offices and therefore indicators are not directly comparable.** Due to different disclosure obligations and examination procedures, European searches differ substantially from USPTO searches, and so do the citations generated in the two processes. This means that researchers wishing to employ patent citation analysis need to be aware of these differences.

169. Applicants to USPTO are legally required to include a full list of prior art known or believed to be relevant ("duty of candour") – these are then evaluated and/or supplemented by the examiner. Examiners consider all disclosed prior art with few exceptions. There is a strong motive to provide references of prior art in the USPTO system, because failing to provide all relevant references can result in patent litigation and severe penalties.[51] However, in view of the sometimes excessive number of weakly relevant references given by certain applicants, revised USPTO rules in 2006 (not yet implemented by

50 In a survey of patentees and inventors, around one-half of all patents citations (in a cohort of 1993 patentees at the USPTO) were found not to correspond to any perceived communication, or even to a perceptible technological relationship between the inventions (*e.g.* Jaffe *et al.*, 2000).

51 Published applications of the USPTO (called pre-grant publications) include the applicant's citations but they do not include those of the examiner. The latter are only published if and when the patent is granted.

2007) proposed to introduce a maximum of 20 references to be provided by the applicant – any further reference beyond this number should come with explanations.

170. At EPO no such requirement exists – citing of prior art within the application document on the part of the applicant or the applicant's patent attorney is optional.[52] Most citations in PCT and EPO publications (about 95%) are added by examiners in the search report. Though examiners are responsible for constructing the list of prior art references (provided in the search report) against which patentability is judged, they rely in part on applicant disclosure of the prior art submitted with the patent application (*e.g.* at the EPO, this is done in the information disclosure statements).

171. Furthermore, the European search report should include (as references) the most important documents, or the earliest of equally important documents. According to EPO philosophy, a good search report contains all relevant information within a minimum number of citations.[53] Some have noted that certain applicants to USPTO may provide more references than necessary (until the 2006 reform). This, combined with EPO examiners' minimalist approach, goes some way to explain the fact that the average number of citations in USPTO patents is significantly greater than those in found in EPO patents (see Table 6.2).[54]

172. In the case of JPO, patent examiners conduct the search of the prior art; however, applicants are also required to disclose information on prior art beforehand (in practice since 2002 and in full force since May 2006). There is no limitation on the number of references to be included.

173. As regards EPO and PCT citations, the following issues must be considered (see Webb *et al.*, 2005):

- Citations contained in the international and/or regional search reports may differ. One problem concerns the (partial) substitute character of information contained in WO search reports (the International Search Report).[55] If the EPO receives filings that were treated first by other ISAs (International Search Authorities), the EPO will undertake a supplementary search which is summarised in the Supplementary Search Report.[56]

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52 For further details, see the *Guidelines for Examination in the European Patent Office,* updated regularly. Following a general section, the guidelines are divided into five sections comprising among others, guidelines for formalities examination, guidelines for search, and guidelines for substantive examination.

53 If the search results in several documents of equal relevance, the search report should normally contain no more than one of them. The decision of which one to use for citation is made according to the expert knowledge of the examiner. In case of two documents of equal relevance, one of which was published before the date of priority and the other published between priority date and filing date, the search examiner should choose the earlier one.

54 As shown by Callaert *et al.* (2006) in a comparative study of USPTO and EPO patents, these differences are noticeable both in terms of the occurrence and the type of the reference cited. USPTO patents include on average about three times more patent references than EPO patents. As regards non-patent literature, 34% of patents in USPTO contain non-patent references whereas in EPO, this is 38%. They also find that journal references are more prominent in EPO patents (64% of non-patent references are journal references in EPO, 54% in USPTO).

55 For patents which later enter the regional phase at the EPO, the EPO acts as the ISA. Formally, the international search report has a different function than the search report issued by the EPO for applications that were filed directly at the EPO. Practically, there are few differences. International search reports for WO documents are generated by one of 12 ISAs. These are the patent offices of Australia, Austria, China, Finland, Japan, Korea, Russia, Spain, Sweden, the United States and the European Patent Office.

56 For further information see the *PCT International Search and Preliminary Examination Guidelines* of the WIPO; see www.wipo.int/pct/en/texts/pdf/ispe.pdf

- This phenomenon is particularly important given that an increasing number of applicants file patents under PCT before entering the EPO process in the “regional phase”. When this occurs, most citations will appear in the international (WO) document rather than the EPO document. In order to count citations correctly, information from both the international and the European searches needs to be combined.

174. Until recently, most citations indicators compiled would be restricted to a single office: only for references from EP patents to prior EP patents, or US to US patents. For EP patents, it has been pointed out that roughly three-quarters of the references are not being used. Taking the full data into account may powerfully affect citation indicators. For instance, the inclusion of citations in the PCT international stage (WO) with EP equivalents shifts the citation lag (time difference between the cited and the citing patents) distribution significantly: the median lag shifts from 4.0 to 6.7 years; the maximum lag moves from 25.7 to 132 years (Harhoff *et al.*, 2006).

175. There are several issues that need to be taken into account when working with patent and non-patent citations. We mention here some of the most important for counting citations:

176. **Patents documents do not have a one-to-one relationship to inventions.** Citations to a patent can occur in different ways. One and the same invention can be covered by a number of documents issued by different national or supranational offices (Harhoff *et al.*, 2006).[57] A patent can be cited as a national patent publication or international/regional, or as one of its equivalents (at USPTO, EPO or JPO). As explained in Chapter 4, all of the published patent applications from various countries and the subsequently granted patents on an invention are commonly referred to as patent equivalents. A group of patent equivalents makes up a patent family; that is, a set of patents (or applications) filed in several countries to protect the same invention. They are related to each other by one or several common priority numbers. When these different citations are not taken into account, counts of citations are underestimated because citations of a given invention are spread across the different versions of a patent family.

177. At the EPO, referencing seeks to use the earliest and most easily available “incarnation” of an invention, preferably in the language of the applicant. In EPO documents, the majority (about three-quarters) of references refer to non-EP documents. In this regard, Michel and Bettels (2001) show that 90% of the total number of patent citations made by the EPO refer to EP, DE, GB, WO, or US documents. Citation counts based only on EP documents are biased downwards in this context. In the case of US patent citations, the problem is present as well, but to a much smaller extent as the USPTO mainly references USPTO documents. At the USPTO and the JPO, 90% or more of the references in the search reports refer to national documents (Michel and Bettels, 2001).

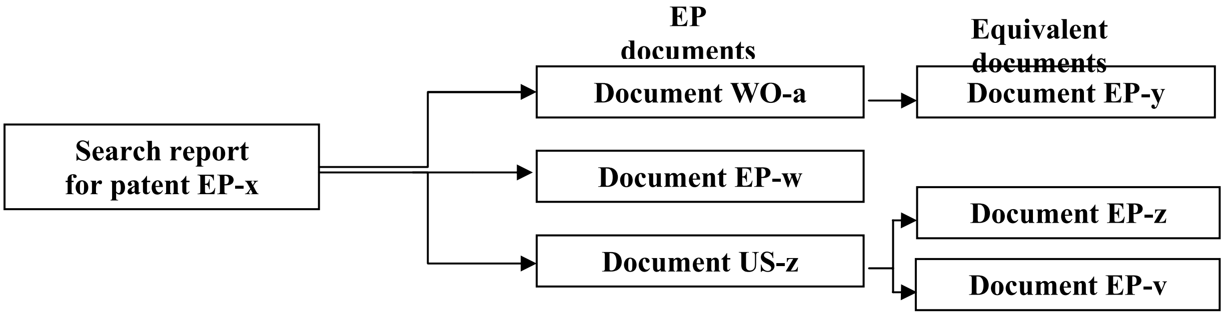
Box 6.1. The problem of equivalents

The case of European patent citations (Harhoff *et al.*, 2006)

Counts of European patent citations have been used in economic analysis in a number of cases, but rarely have these studies tackled the *problem of equivalents* (a patent that relates to the same invention and shares the same priority application as a patent from a different issuing authority; see Chapter 4 for definitions of patent families). The structure of this problem is described in the figure below. The search report for patent application EP-x references patent document WO-a, EP-w and US-z. However, document WO-a has an equivalent EP-y among EPO-filed applications. The patent application underlying document US-z has two equivalents (EP-z and EP-v) within the EP system.

57 In the context of EPO patent citations, in case an invention is protected in more than one country and, therefore, several documents belong to a single patent family, the examiner should preferably cite the patent document in the language of the application. The choice is also affected by the languages with which the examiner is familiar. When patent documents are not referenced as European, but as equivalent documents issued by other patent offices such as WIPO, USPTO, DPMA and others, citation counts will typically inform the analyst about the source of references, but not about the importance of particular inventions.

Referencing of equivalent documents



This pattern of referencing is in no way erroneous. Given time constraints, bottlenecks in documentation systems or simply language preferences, this is a frequently observed pattern. However, for a researcher who wishes to know how often particular patents (*e.g.* EP-y, EP-z or EP-x) have been cited in one of its (equivalent) incarnations, simply counting the uncorrected occurrence of references is misleading. Prior to the count, all non-EP documents would have to be relabeled to their EP equivalent application number(s) in order to obtain correct counts of citations.

To be more precise, the rule that can be applied can be summarised as follows: *Let X and Z be different patent offices. A reference to an X-system patent document should be taken as a valid citation count of a particular Z-system patent if the X-system document is an equivalent of the Z-system patent.* In a significant number of cases, the referenced non-EP document is linked to more than one EP equivalent, as indicated in the figure above. In these cases, fractional counting can be applied, *i.e.* the citation counts and other statistics will weight the incidence (or statistical data) of each of the multiple EP equivalents by the inverse of the number of multiple EP equivalents.

6.5. Citation-based indicators

6.5.1 Benchmarking citations

178. Information on patent citations is meaningful only when used comparatively. There is no natural scale or value measurement associated with citations data. Standing by itself, the fact that a given patent has received 10 or 100 citations does not tell you whether that patent is “highly” cited. In other words, the evaluation of the patent intensity of the citation intensity of an invention, an inventor, an institution, or any other group of reference, can only be made with reference to some “benchmark” citation intensity.

179. In principle, it is possible to identify and quantify the changes in citation intensity that are associated with the different effects. However, it is not clear if the observed patterns can be real or artefactual, and indicators can be therefore misinterpreted. Consider for instance, some of the stylized facts found in USPTO patent citation data: *i)* the average number of citations received by patents in their first five years has been rising over time; *ii)* the average number of citations made per patent has been rising over time; and *iii)* the observed citation-lag distributions for older cohorts have fatter “tails” than those of more recent cohorts.

180. With respect to the first fact in isolation, one might conclude either that more recent patent cohorts are more “fertile”, or that the citation-lag distribution has shifted to the left (citations are coming sooner than they used to). Considering the second fact in isolation, one could think that there has been an artefactual change in the propensity to make citations. But since the stock of patents available to be cited has been growing at a rapid (and accelerating) rate, this is not clear. The last fact, taken by itself, seems to suggest that the citation-lag distribution has shifted to the right. Without further assumptions one cannot tell which of these competing scenarios is “correct”, and hence one cannot make any statistical adjustments to the citations data, including adjustments for truncation of lifetime citations.

181. The determination of the appropriate benchmark is complicated by several phenomena that are inherent to the patent citations data (Hall *et al.*, 2001).

- First, *the number of citations received by any given patent is truncated* in time because we only know about the citations received so far. More importantly, patents of different ages are subject to differing degrees of truncation. More recent patents have intrinsically less time to be cited.

- Second, *differences in patent examination practices* across time may produce differences in citation intensities that are unrelated to the true impact for which we use citations as a proxy. In the NBER USPTO patent citation data, the average patent issued in 1999 made over twice as many citations as the average patent issued in 1975 (10.7 versus 4.7 citations).

- Third, the problem created by the increase in the number of citations made per patent is exacerbated by the *fact that the number of patents issued has also been rising steeply* in several patent offices. Even if each patent issued made the same number of citations as in the past, the increase in the universes of "citing patents" would increase the total number of citations made. The combination of more patents making more citations suggests a kind of citation "inflation" that may mean that later citations are less significant than earlier ones, from a statistical perspective.

- And lastly, *the number of citations made (and received) per patent varies considerably by technological field or maturity of technology*. In general, the traditional technological fields cite more and are cited less, whereas the emerging fields of Computers & Communications and Drugs & Medical are cited much more but are in between in terms of citations made. The degree of dependence on past technology or 'cumulativeness' determines the propensity to cite other patents; for instance, technologies such as semiconductors show typically higher backward citation intensity.[58]

182. Two generic approaches used in the literature deal with these problems. The first, "*the fixed-effects"* approach, involves scaling citation counts by dividing them by the average citation count for a group of patents to which the patent of interest belongs. This approach assumes that *all* sources of systematic variation over time in citation intensities are artifacts that should be removed before comparing the citation intensity of patents from different cohorts. That is, citation intensities are "re-scaled", expressed as ratios to the mean citation intensity for patents in the same cohort.

183. If we want to compare a 1990 patent with two citations to a 1985 patent with four citations, we divide each by the average number of citations received by other patents in the same cohort. This rescaling purges the data of effects due to truncation, effects due to any systematic changes over time in the propensity to cite, and effects due to changes in the number of patents making citations. Unfortunately, it also purges the data of any systematic movements over time in the importance or impact of patent cohorts. The advantage of this approach is that it does not require one to make any assumptions about the underlying processes that may be driving differences in citation intensities across groups. The disadvantage is that, precisely because no structure is assumed, it does not distinguish between differences that are "real" and those that are likely to be artefactual.

184. The second or "*quasi-structural"* approach attempts to distinguish the multiple effects on citation rates via econometric estimation. Once the different effects have thereby been quantified, the researcher

58 The citation propensity also differs over time across technological areas. Citations in Computers & Communications, arrive the fastest, followed by Electric & Electronics, and Drugs & Medical technologies (Hall *et al.*, 2001).

has the option to adjust the raw citation counts to remove one or more of the estimated effects. If the assumptions inherent in the econometric estimation are correct, this approach permits the extraction of a stronger signal from the noisy citation data than the non-structural, fixed-effects approach (see Hall *et al.*, 2001, for further details on the estimation method).

6.5.2 Backward citation indicators

185. There are two groups of indicators that can be constructed with citations. The first group concerns indicators based on backward citations, which are useful to assess the degree of novelty of the invention and knowledge transfer patterns (*e.g.* citation networks). The second are impact type indicators, based on forward citations. Beyond that, one can construct citations-based measures that may capture other aspects of the patented inventions, such as 'originality', 'generality', 'science-based' (*e.g.* Trajtenberg *et al.*, 1997, Narin *et al.*, 1997; Sampat and Ziedonis, 2004).

186. *Technological cumulativeness* is defined by the frequencies of self-citation of the patents produced in the prior research by a company. The identification of *self-citation* (applicant/assignee) has important implications, *inter alia*, for the study of spillovers: presumably citations to patents that belong to the same assignee represent transfers of knowledge that are mostly internalised, whereas citations to patents of "others" are closer to the pure notion of (diffused) spillovers. It is more convenient to exclude self-citations (when information on consolidated patent data by applicant is available) when investigating knowledge transfer and/or citation impact of inventions.

187. A common measure of *cumulativeness* at the level of the company is the sum of backward citations made to patents the firm owns over the total patents owned by the firm (at a given time *t*). According to Malerba and Orsenigo (1995), cumulativeness implies that leading innovators have an edge over the laggards and the former may continue to lead in the future.

188. *Citation lags:* The term "citation lag" refers to a measure of time passing between a characteristic date of the referencing patent application and a characteristic date of the cited document.

189. The lag is then time difference between the application, publication or grant year of the citing patent, and that of the cited patents. Citation lags can be computed in various ways, *e.g.* based on priority, application, or publication dates. There are then two ways to look at citation lags: backwards and forward. The lag measure computed in the OECD EPO citation dataset is defined as the time between the publication of the cited patent application (in general, patent or non-patent literature cannot be cited before it is published, except for an invention applied for by the same applicant) and the publication date of the referencing search report (Webb *et al.,* 2005). Some implications of this choice need to be pointed out.

- For most of the cited patent documents originating with European patent offices or the JPO, publication (including the disclosure of search results to the public at large in the case of EPO) occurs exactly 18 months following the priority date. Hence, for the computation of citation lags of European or Japanese patents, it does not matter if we choose the date of the search report (the priority date for Japanese patents) or the date of the publication of the application. One could take as reference the priority date of the citing patent with the publication date of the cited patent.

- If the cited document is a US patent which was only pursued within the United States, the earliest publication date was the grant date until November 2000, and applicants can still keep to this rule if they wish so. If the cited US patent has an international equivalent, the corresponding international applications are again published 18 months after the US priority date.[59]

- For patent documents with the international search report published by WIPO and a supplementary search report published by EPO or other ISA, we have multiple publication dates. If the referenced documents have no overlap, the lag can be computed with respect to the date of the publication of the relevant search report. If the international search report and the EPO supplementary search report reference the same document, we can drop the later entry from the list and take the earliest publication date of the two search reports for computing the citation lag.

190. *Technology cycle time (TCT):* Based on the measure of citation lags, a company-level indicator can be computed. The technology cycle time indicates speed of innovation or how fast the technology is turning over, defined as the *median age* in years of the patent references cited on the front page of the company's patents. Companies with shorter cycle times than their competitors are advancing more quickly from prior technology to current technology. In semiconductors, cycle times are short (3-4 years); in shipbuilding they are long (more than 10 years). The average is eight years.

6.5.3 Forward citation indicators

191. *Forward citations per patent:* This is considered as a measure of the technological impact of inventions. Several studies have shown that the number of citations a patent receives is associated with its technological importance and social value (Trajtenberg, 1990; Scherer *et al.*, 1999) and is correlated with the renewal of patents, the estimated economic value of inventions and the probability of the patent being opposed (Lanjouw and Schankerman, 1999; Harhoff *et al.,* 2002, 2003).

192. The *citation impact* is the count of forward citations but expressed as a relative term (see disadvantages in using this approach when comparing indicators over time, Section 7.1). It is the number of times a patent is cited relative to the number of citations received in average by a patent in the same technology field (four-digit IPC subclass) and having the same invention date (priority year). This approach permits to control for the differences in citation frequency across technology fields and the truncation effect related to time (earlier patents having an intrinsic lower probability of being cited, see Hall *et al.*, 2001).

193. The *generality of a patent* is built as a Herfhindal index (Trajtenberg *et al.*, 1997; Hall *et al.*, 2001): $Generality = 1 - \sum_{i}^{ni} s_{ij}^{\;2}$, where s_{ij} denotes the percentage of citations received by patent i that belong to patent class j, out of n_i patent classes.[60] A high generality score suggests that the patent had a widespread impact, since it influenced subsequent innovations in a variety of fields. The *geographical impact* of a patent can be built in a similar way (1-Herfhindhal index of geographical concentration), *i.e.* across the different countries of origin of inventors in the citing patents. The *"originality*" of a patent can be defined the same way, except that it refers to patent backward citations. Thus, if a patent cites previous patents that belong to a narrow set of technologies the originality score will be low, whereas citing patents in a wide range of fields would render a high score.

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59 Under the American Inventors Protection Act (AIPA) enacted 29 November 1999, all patents which seek some form of patent protection outside of the United States are published by the USPTO, again 18 months after the US priority date. That does not change the timing of the earliest publication, but the publication is now available from the USPTO and will show up in our data even if we do not detect European equivalents of the US patent.

60 If a patent is cited by subsequent patents that belong to a wide range of fields the measure will be high (close to one), whereas if most citations are concentrated in a few fields it will be low (close to zero).

194. Some considerations must be taken into account when calculating this type of indicator:

- Note that the originality and generality measures depend upon the patent classification system: a finer classification would render higher measures, and conversely for a coarser system (ibid). Thus a finer classification within a field (*e.g.* in terms of number of three-digit patent classes), will likely result *ceteris paribus* in higher originality and generality measures, and one may justly regard that just as an artefact of the classification system.

- As shown by Hall *et al.* (2001), the generality measure is biased upward when the number of patents on which it is based is small. Basically, if there is some ‘‘true’’ probability of a random patent being in one of many classes, the true concentration may be low; if very few patents are actually observed, they can only be in a few classes, and the measured concentration will be high. The indicator needs to be then adjusted by the size of observations.[61]

195. At the company level, several indicators are used for measuring the impact of patents (Narin, 2000).

- *Current Impact Index (CII):* The number of times a company's previous five years of patents are cited in the current year, relative to all patents in the US patent system, indicates patent portfolio quality. A value of 1.0 represents average citation frequency; a value of 2.0 represents twice average citation frequency; and 0.25 represents 25% of average citation frequency. This allows to benchmark a company's technological quality against other companies and against the average for the technology. CIIs vary by technology area. For example, they are high in semiconductors, biotechnology, and pharmaceuticals, and low in glass, clay & cement, and textiles.) CII has been found to be predictive of a company's stock market performance.

- *Technology Strength (TS)*: Quality-weighted portfolio size, defined as the number of patents multiplied by current impact index. Using TS you may find that although one company has more patents, a second may be technologically more powerful because its patents are of better quality. Companies with highly cited patents may be more advanced than their competitors, and have more valuable patent portfolios.

- *The Citation Performance Index:* This consists in computing a relative index expressing the number of patents found in the most highly cited (*e.g.* 10%) for a particular country (entity) with those of the world (or other reference). This indicator measures as well the impact of quality of the patents of a certain reference group. For a country, the formula for the indicators is: the percentage of country *i*'s patents appearing among the most cited 10% relative to the same percentage for the world's patents.

[61] The methodology to calculate the magnitude of the bias -- and correct the bias -- are reported in Hall *et al.* (2001).

6.6 Non-patent literature

196. Science linkage indicators are based on counts of references to the non-patent literature considered as scientific. The identification of "scientific" non-patent references provides insights into technologies that are closer to scientific R&D and thus more dependent on the progress of scientific knowledge. There is some recognition that non-patent references are useful to investigate the interplay between science and technology. The average level of non-patent references has been frequently used as a proxy for quantifying the relationship of a technology field with a scientific domain (Narin *et al.*, 1997; Meyer, 2000; Verbeeck *et al.*, 2002). The more scientific references are to be found in patents, the more the technology is considered to be situated in the vicinity of basic research. The analysis of science linkage in patents can be extended to important policy topics, notably the influence of science to new emerging technology domains, or the value of science for industry (*e.g.* impact on economic value of companies).

197. However, non-patent references need to be treated with caution and some contextual elements should be taken into account when interpreting such indicators. As noted in Section 6.4, differences across patent offices in terms of examination procedures may influence the number and type of references cited. In the case of EPO, as references are issued essentially from the examiner's revision of the prior art, it has been argued that citations rarely reflect or coincide with the science used by inventors. Other researchers indicate that non-patent references barely represent a unidirectional direct link to science and that it is difficult to establish causation between the two documents, the citing patent and cited article (Tijssen, 2002).

198. Non-patent literature (NPL) consists not only of peer-reviewed scientific papers but also includes other types of publications: conference proceedings, databases (DNA structures, gene sequences, chemical compounds, etc.) and other relevant literature (translations guides, statistical manuals, etc.). Table 6.3 displays the occurrence of journal and non-journal sources in USPTO and EPO and Table 6.4 reports the types of non-journal sources. Within the non-journal sources, conference proceedings, industry-related documents and databases are the most frequently cited. References to non-scientific documents such as "patent abstracts" and commercial online patent database services should be removed for the purposes of analysis of science linkage in patents.

199. An analysis of over 540 000 international patent applications (filed under the Patent Co-operation Treaty, PCT) published by the European Patent Office (EPO) shows that in the last 15 years the IPC sub-classes with a higher than average share of citations to NPL (over 15%) are mainly in the fields of biotechnology, pharmaceuticals, other fine organic chemistry and ICT (Figure 6.1).[62] Higher shares of NPL in citations occur in countries whose international patenting activity is more concentrated in these high-activity or emerging technology fields (Figure 6.2). For example, Indian inventors have a recent history of international patenting activity and a relatively high proportion of their applications are in biotechnology and pharmaceuticals, which have closer links to science.

200. For 1990-2004 about 55% of citations in biotechnology-related international patents are to NPL (ibid). There is little cross-country variation suggesting some general homogeneity in the rate of technological advances while hiding some structural differences across countries. For ICT (Figure 6.3), the average share is about 18% and varies across countries in a range of 10 to 25%. Low shares suggest that recent ICT innovations are based more on existing technology while higher shares suggest that certain countries still benefit from scientific R&D in ICT.

62 This is consistent with other observed patterns of science-industry linkages in these fields, such as university spin-offs, industry-university co-operation in R&D and the tendency for biotechnology companies to cluster around universities.

201. Once non-patent references with a scientific content have been identified, the influence of science can be disentangled in a more substantive manner. With the aid of databases on scientific publication, scientific disciplines and affiliations of the authors and institutions can be linked to patent information. Linking the technology domain of the citing patent to the science field of the cited publication, for instance, results in matrices that represent the presence of specific scientific disciplines and that relate them to different technological domains (Schmoch, 1997; Verbeek *et al.,* 2002).

202. A simple indicator at the company level is the average number of science references cited on the front page of the company's patents. High science linkage indicates that a company is building its technology based on advances in science ("closeness to science"). High-tech companies tend to have higher science linkage than their competitors and science linkage has been found to be predictive of a company's stock market performance (*e.g.* Nagaoka, 2007).

6.7 Other indicators based on the categories of citations (EPO and PCT search reports)

203. PCT and EPO search reports assign codes to the references constituting the prior art of an invention (Schmoch, 1993). EPO publications include information for five different types of citations: *i)* added by examiners during the search (whether or not provided by the applicant); *ii)* provided by the applicant but not used in the search report; *iii)* added during examination; *iv)* provided during opposition proceedings; and *v)* other. All documents cited are identified by a particular letter in the first column of the search report representing the cited category (combinations of codes are possible). See Table 6.1 for definitions of citation categories.

204. This categorisation can be helpful for building more refined indicators on citations, for instance, indicators on patents with capacity of blocking other inventions (based on X, Y and E categories). The categories X and Y, which designate the citation to a relevant document in the prior art, are very important in assessing the patentability of a new invention and can compromise the grant of a patent. X-type references are the most important ones in this sense. In case an application receives an X classification, this indicates that the claimed invention does not meet wholly or partly the requirements of novelty or of inventive step, and that one claim at least needs to be modified in order not to interfere with the legal boundaries of other existing inventions. As a result, when looking at granted patents having these categories of backward citations, the claims that appear, have been, in most of the cases, modified during the granting process. In the search report, the search officer or examiner actually indicates to which claims of the application the prior art applies to in a critical way.

205. Documents cited by the applicant (type D) should be considered in the search report if they are decisive as to the state of the art, or when they are necessary for the understanding of the application. Citations submitted by the applicant which do not fulfil these requirements may be disregarded by the examiner. Type A references merely provide technical background information (state of the art). The fact that a patent is frequently cited and as invalidating some or all of the claims of other patent applications might reflect also some strategic behavior of patent holders, who design their applications in broad terms in order to bar or reduce the patentability of follow up inventions by competitors.

Table 6.1. Citation categories at the EPO and PCT

X	Particularly relevant documents when taken alone (a claimed invention cannot be considered novel or cannot be considered to involve an inventive step)
Y	Particularly relevant if combined with another document of the same category
A	Documents defining the general state of the art
O	Documents referring to non-written disclosure
P	Intermediate documents (documents published between the date of filing and the priority date)
T	Documents relating to theory or principle underlying the invention (documents which were published after the filing date and are not in conflict with the application, but were cited for a better understanding of the invention)
E	Potentially conflicting patent documents, published on or after the filing date of the underlying invention
D	Document already cited in the application (provided by the applicant)
L	Document cited for other reasons (*e.g.* a document which may throw doubt on a priority claim)

Source: EPO Guidelines for Examination in the European Patent Office, 2003 (176*ff.*)

Table 6.2. Occurrence of patent and non-patent references (USPTO – EPO)

USPTO granted patents with application year between 1991 and 2001					
Total # patents (1)	1,299,817	Total # references	17,757,797		
# patents containing patent references	1,173,593 (90%)	# patent references	14,738,854 (83%)	Technology-intensity *With (1) as denominator:*	12.55 *11.33*
# patents containing non-patent references	445,466 (34%)	# non-patent references	3,018,943 (17%)	NPR-intensity *With (1) as denominator:*	6.77 *2.2*
EPO granted patents with application year between 1991 and 2001					
Total # patents (1)	342,704	Total # references	1,698,218		
# patents containing patent references	334,413 (98%)	# patent references	1,404,241 (83%)	Technology-intensity *With (1) as denominator:*	4.20 *4.09*
# patents containing non-patent references	130,511 (38%)	# non-patent references	293,977 (17%)	NPR-intensity *With (1) as denominator:*	2.25 *0.86*

Source : Callaert *et al.* (2007)

Table 6.3. Occurrence of journal and non-journal references in USPTO and EPO: observed values (row percentages between brackets)

	Journal	Non-journal	Total NPRs
USPTO	2766 (55%)	2242 (45%)	5008
EPO	3218 (64%)	1803 (36%)	5021
Total	5984	4045	10029

Source : Callaert *et al* (2007)

Table 6.4. Occurrence of non-journal sources in USPTO and EPO: observed values (column percentages between brackets)

	USPTO	EPO	Total
Conference proceedings	381 (17%)	612 (34%)	993
Industry-related documents	560 (25%)	304 (17%)	864
Books	333 (15%)	186 (10%)	519
Reference books/databases	234 (10%)	600 (33%)	834
Patent-related documents	327 (15%)	46 (3%)	373
Research/technical reports	138 (6%)	27 (2%)	165
Newspapers	106 (5%)	10 (0%)	116
Unclear/other	163 (7%)	18 (1%)	181
Total	*2242 (100%)*	*1803 (100%)*	4045

Source : Callaert *et al.* (2007)

Figure 6.1. Share of NPL in citations in search reports of PCT patent applications

1990-2004, by IPC sub-class[1]

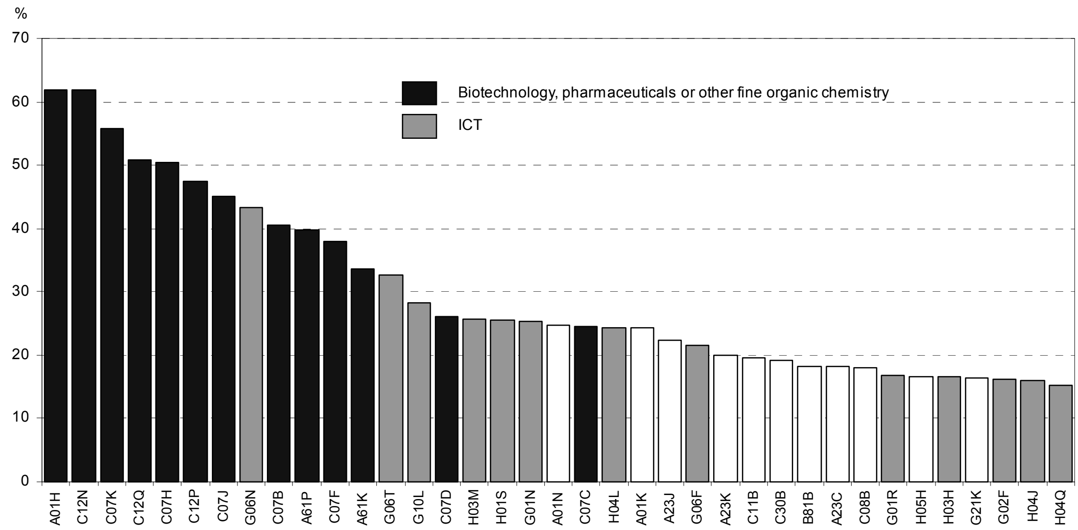


Figure 6.2. Share of NPL in citations – all patents

1990-2004, by country of inventor[2]

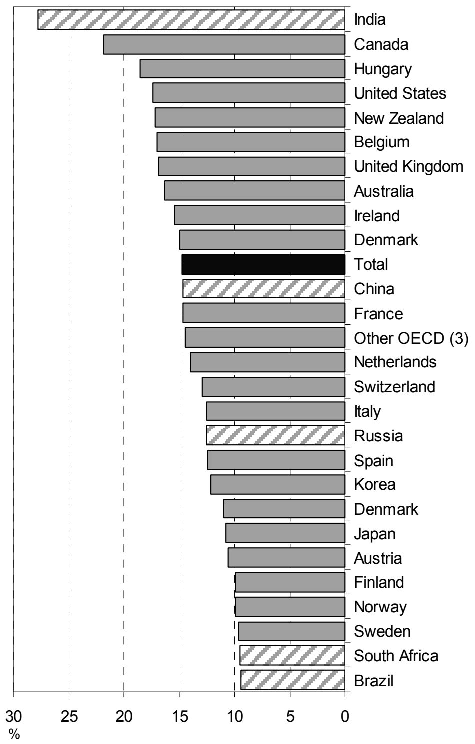


Figure 6.3. Share of NPL in citations –ICT

1990-2004, by country of inventor[2]

1. Only those IPC sub-classes (out of over 600) with a share of NPL citations greater than the average (14.7%) and with more than 150 patent applications published in the period 1990-2004.
2. Fractional counting used when there is more than one inventor on the patent application.
3. Other OECD includes Czech Republic, Greece, Iceland, Luxembourg, Mexico, Poland, Portugal, Slovak Republic and Turkey.

Sources: OECD, EPO Patent Citations Database 2006.

CHAPTER 7

INDICATORS OF INTERNATIONALISATION OF SCIENCE AND TECHNOLOGY

7.1 Introduction

206. Inventive activities are increasingly organised at the international level (OECD, 2007). Inventions made by researchers residing in one country can be funded and owned by foreign companies, companies from different countries can join their resources to sponsor research, and researchers from different countries can co-operate for doing inventions, etc. Alliances across different geographic locations are created to obtain synergies and complementarities in research and to acquire new technological competences. The advent of global value chains, differences in R&D costs, increased flexibility in handling cross-border R&D projects (owing to ICT), and major policy changes (such as stronger intellectual property rights or the tax treatment of R&D) have all favoured this trend. Given the importance of these changes and their implications on the technological capacity of countries, it is important to quantify the intensity and geographical patterns of these activities.

207. Different indicators are available to measure the internationalisation of science and technology (S&T). These are based notably on research and development (R&D) and international trade statistics, such as the share of R&D financed by sources abroad, exports and imports of high-technology products, and receipts and payments in technology services (OECD, 2005). As regards the internationalisation of R&D activities, the analysis relies on data from surveys on the activities of multinational firms and case studies. Information from business surveys provide important insights on the activities by foreign affiliates (*i.e.* OECD-AFA Database) but their coverage remains limited to few countries.

208. Internationalisation of technological activities can also be examined in the output of inventive activities measured with patents. Patent documents show the inventor(s) and the applicant(s) – the owner of the patent at the time of application – along with their addresses and thus their country or countries of residence. The exploitation of this information, separately or jointly, can tell much about the geographical organisation of inventions. This is reflected in the indicators presented in this chapter. Other information can also be used, such as citations: patents citing other patents corresponding to inventions made in another country reflect international knowledge flows. Citation-based indicators have been presented in Chapter 6 and will not be addressed in this chapter.

7.2 Indicators

7.2.1 Cross-border ownership of inventions

209. When the applicant's and inventors' country of residence differ, this indicates cross-border ownership. Using the information contained directly or indirectly in patent documents, two indicators of

cross-border ownership can be computed at the country or regional level (Guellec and van Pottelsberghe, 2001):

- **Foreign ownership of domestic inventions:** This refers to the number of patents which are granted to applicants residing abroad (for reference country i, foreign country j=1,….N, j≠i) and which have at least one domestic inventor ($P_{i,j}$), divided by the total number of patents invented domestically (P_i). The foreign ownership in the total of domestic invention for country i is then: $\frac{\sum_{j=1}^{N} P_{i,j}}{P_i}$.

- **Domestic ownership of inventions made abroad:** This refers to the number of patents which are granted to a country but whose inventions have been made abroad with at least one foreign inventor ($P_{j,i}$), divided by the total number of patents owned by the country (P_j). The domestic ownership in the total of owned patents, for country i, is then: $\frac{\sum_{i=1}^{N} P_{j,i}}{P_j}$

210. In most cases, patents with inventors from abroad correspond to inventions made at the research laboratories of multinational companies and applied for at company headquarters (although in some cases national subsidiaries also may own or co-own the patents). Hence, the first indicator expresses the extent to which foreign firms control domestic inventions. Similarly, the second reflects the extent to which domestic firms control inventions made by residents of other countries.[63] Hence these indicators reflect first the role of foreign affiliates of multinational companies in inventive activities. They complement data on R&D of foreign affiliates of multinational firms. Foreign control means that the economic benefits coming out of inventions are shared between countries: the country of invention, the country of ownership, but also partly other countries as multinational companies might implement part of their technology at worldwide level (in terms of manufacturing or sales).

7.2.2 International co-operation in research

211. Another measure of internationalisation of technology is **international co-operation in research** as measured by patents involving inventors from a different country of residence. It refers to the number of patents invented by a country (reference country *i*, foreign country *j=1,....N, j≠i*) with at least one inventor located in a foreign country ($P^{i,j}$), in the total number of patents invented domestically (P^i). The share of international co-inventions in the total of domestic inventions for country *i* is then: $\frac{\sum_{j=1}^{N} P^{i,j}}{P^i}$.

212. As countries differ in specialisation and knowledge assets, complementary external knowledge can be found abroad. International collaboration by researchers can take place either within a multinational corporation (providing research facilities in several countries) or through a research co-operation between several firms or institutions (collaboration between inventors belonging to different universities or public research organisations). In that sense, co-invention indicators also reflect international flows of knowledge.

213. Indicators of cross-border ownership and of co-invention are not independent from each other. International co-invention by definition will involve cross-border ownership. In fact, cross-border ownership can be broken down by inventions which do or do not involve co-invention (the applicant country also being an inventor). Naturally, what is accounted for as foreign ownership in one inventor country implies a domestic-owned invention abroad by domestic firms in another country. Thus the

63 Some fraction of these patents subject to cross-border ownership might also represent a co-ownership between two companies located in different countries; but again, this more likely concerns cases of co-ownership between headquarters and foreign subsidiaries. However, this represents a very small share of total patents with cross-border ownership.

worldwide total of patents with foreign ownership of inventions is the same as domestic ownership of inventions, total patents subject to cross-border ownership. Not surprisingly, worldwide totals are pretty much lower than the figures reported by some countries, as counts are consolidated.

214. Figure 7.1 reports the evolution of worldwide cross-border ownership and co-invention during the period 1990-2002 in patent applications at the European Patent Office (EPO). The former is the percentage of patents with at least one inventor residing in a different country than the owner of the patent (in total worldwide inventions), whereas the latter is the share of patents with at least two inventors residing in different countries in total worldwide. Over this period, international co-invention more than doubled from around 3% in 1990 to over 7% in 2002. The share of cross-border ownership has grown steadily worldwide; it increased by 50% between the early 1990s and the early 2000s. That is, in 2002, more than 1.5 of 10 patents applied for at the EPO were subject to cross-border ownership. Figures 7.2 and 7.3 report the indicators on foreign ownership and domestic ownership of inventions made abroad for a group of countries.

7.2.3 Advantages and caveats of patents in measuring internationalisation of S&T

215. The advantages of using patent indicators for tracking internationalisation of technology are numerous. Patents provides a reasonably complete description of the invention, the technology field concerned, the inventor (name, geographical location, etc.), the applicant (ibid), references or citations to previous patents and scientific articles to which the invention relates, amongst other things. Internationalisation of technology can be tracked by technology field, type of firms (when company data are available, *e.g.* size), university-industry linkages, etc.

216. The most important difficulties in measuring the internationalisation of technology with patent information come from the complexity of the companies' ownership structure and strategy and the lack of information on these aspects, which sometimes makes it difficult to attribute a particular country to the owner company as declared in the patent file. Many of these difficulties, however, have to do with the issue of simply attributing a country to a company, a problem which applies to all indicators of internationalisation (OECD, 2005). Several misleading cases can be found:

- The owner's country as declared in the patent file may in some cases be the affiliate of a multinational group in charge of managing its international intellectual property, and not the multinational company itself. As this affiliate might be located in a different country than the group headquarters (for strategic or tax-related reasons), this will give a distorted picture of cross-country linkages.
- A patented invention can be controlled by a foreign entity *ex-post*, after its initial owner was acquired by or merged with this foreign entity or the patent right was transferred to the foreign entity. The opposite (a foreign-owned company becomes national) can happen as well. The new owner may or may not take direct control of the patent. Standard patent databases do not register such changes in the ownership of patents when they occur after the grant, hence providing an imprecise picture of the actual control of inventions.
- The patent can be owned (or applied for) directly by the domestic subsidiary of a multinational group, which therefore is not mentioned as such in the patent file (see Chapter 5). In that case, foreign ownership is underestimated (*e.g.* see the case of Belgium in Cincera *et al.*, 2006), and symmetrically domestic ownership of foreign inventions is underestimated for the owner's country.

217. Some caution must be taken when interpreting international co-invention activity with patents. The inventors located in different countries frequently belong to the same multinational firm and the company management practices may influence who is mentioned as an inventor (or first inventor, see

Bergek and Bruzelius, 2005). Conversely, inventors located abroad can also be involved due to contracted-out research.

218. The submission of company information (companies' country of origin and international ownership of companies) is not required when applying for a patent. When compiled with the information available in patent files only, the indicators proposed here might underestimate the importance of internationalisation. It is recommended to complement the information on the owner as provided by the patent databases with other information regarding company's ownership, to get more accurate indicators of the internationalisation of technology.

Box 7.1. Regional dispersion of patenting

Indicators presented in this chapter can be compiled at the level of regions as well as countries: indicators of cross-regional ownership and cross-regional co-operation. Although the formulae are similar, the economic interpretation might differ somewhat as cross-region differences and barriers are usually much lower than cross-country ones (*e.g.* language, regulation, tax system, distance). Adaptation of existing technology to local taste, an important motive for locating R&D closer to the final demand, applies more to cross-country investment than to cross-regional investment.

The OECD uses the TL ("territorial levels") classification, which has different levels of aggregation (level 2 consists of about 300 macro-regions; level 3 consists of 2 300 regions, *e.g.* the US BEA economic areas, Japanese prefectures, French "départements", etc.). In EU countries, regions are defined by NUTS (*Nomenclature des Unités Territoriales Stastisques)*, an official classification of the European Commission (which is equivalent to the OECD classification for Europe).

7.3 Ownership and research strategies

219. Globalisation of technological activities as illustrated in patents reflects a mix between research and ownership strategies. Patent data provide further insights on these matters when looking at the combinations between types of ownership (or co-ownership) and types of invention (invention made only abroad or co-invention). Five patterns of internationalisation can be identified in patent data:

- *1: Purely domestic ownership of foreign inventions* (country A owner and country B inventor). This type of strategy refers to patents whose research has been entirely conducted in the foreign laboratory (subsidiary of a multinational corporation).

- *2: Domestic ownership implying co-ownership with one single inventor* (countries A and B owners but only country B inventor). This pattern may reflect co-ownership by the multinational and an affiliate located abroad, or a research joint venture between companies of two different countries.

- *3: Domestic ownership with co-invention* (countries A and B inventors but only country A owner). This pattern concerns patents by multinational firms engaged in twofold internationalisation strategies: exploiting their own knowledge assets and accessing foreign ones.

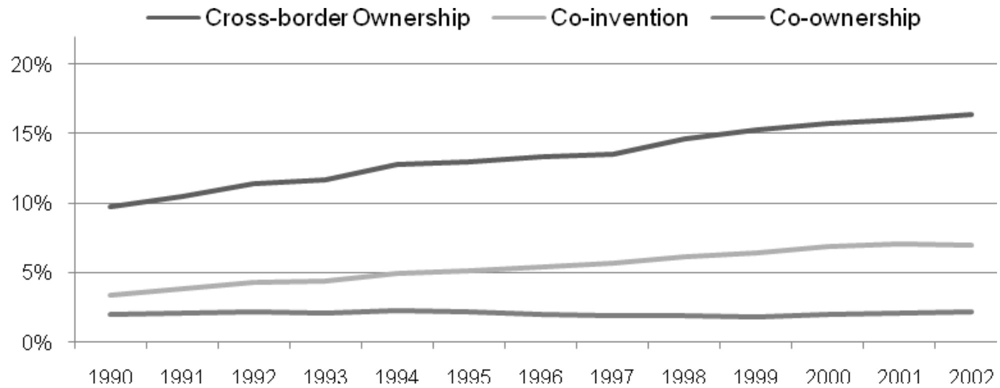
- *4: Co- ownership jointly with co-invention* (countries A and B inventors and owners). This strategy is a combination of the last two types. It might reflect the joint involvement of the headquarters and a foreign affiliate of a multinational firm, or research co-operation between companies in two different countries.

- *5: Cross-border ownership or inventorship with distinct inventor and owner countries* (A and B owners and C inventor). This complex and uncommon pattern requires case-by-case analysis. It might for instance reflect an international network of companies having assigned a third company the management of their patents (*e.g.* technology pools).

220. Figure 7.3 displays the decomposition of patents subject to cross-border ownership. It appears that the predominant strategy in cross-border inventions is one single country owning one invention located in one single inventor country: 47% of patents subject to cross-border ownership are in this category, followed by *single owner countries patents with co-invention* (with the owner country also being an inventor). The latter has increased from 23% during 1990-92 to 29% in 2000-2002, which evidences the growing deployment of mixed strategies (*e.g.* strategic partnerships with the goal of achieving technological synergies for innovation).

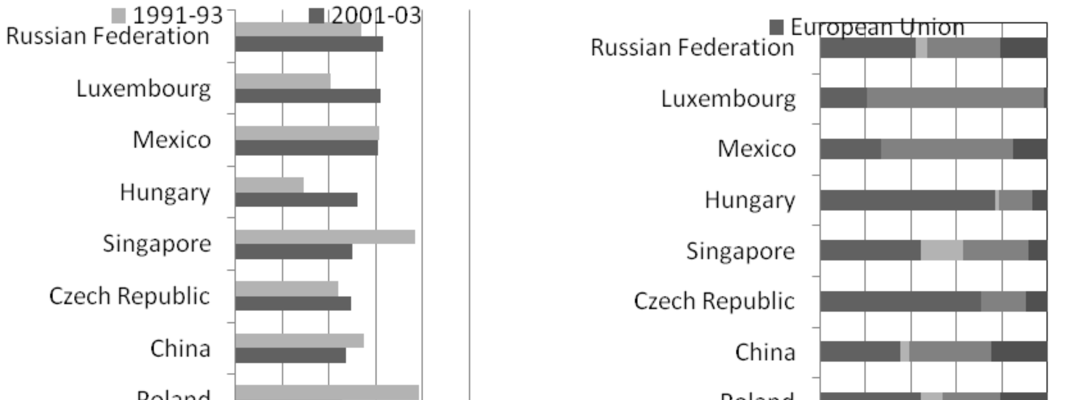
221. The three remaining combinations (*ownership and co-invention, co-ownership and co-invention, and co-ownership with a third country being the inventor*) are less important and their share has actually decreased: patents implying co-ownership in two different countries (multinationals jointly with subsidiaries, or two non-affiliated firms located in different countries with only one country inventor or implying co-invention) represented less than 11% of cross-border patents. Lastly, patents under co-ownership shared between different countries, but none of which is inventor, account for less than 2%.

Figure 7.1. Globalisation of S&T
EPO-PCT applications 1990-2002



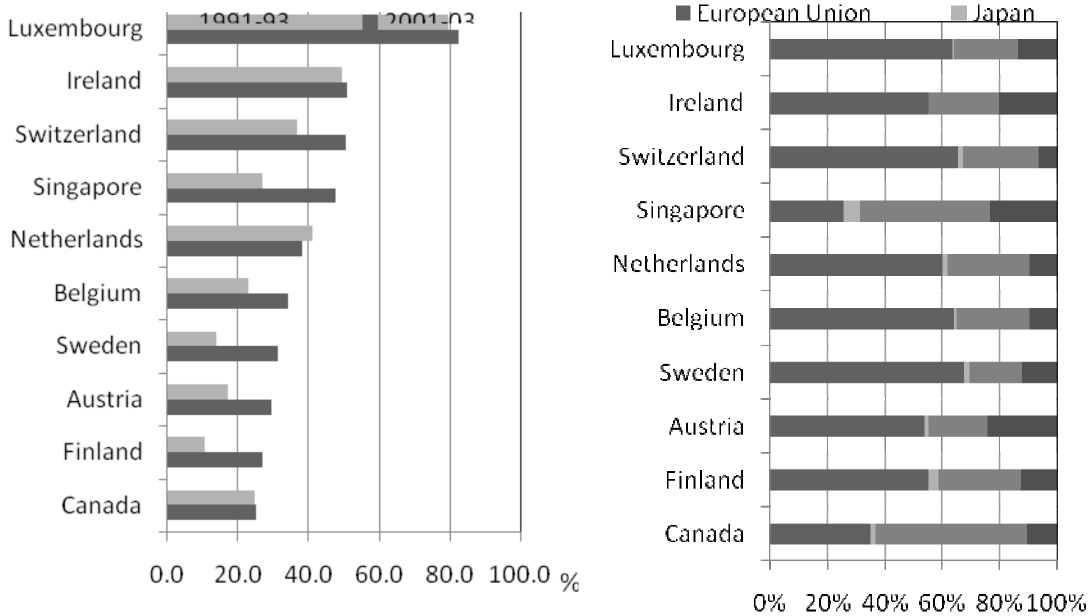
Note: Patent counts are based on the inventor's country of residence, the priority date and fractional counts. Patent applications filed under the Patent Co-operation Treaty (PCT) and designating the European Patent Office. Cross-border ownership: share of patents in total inventions worldwide having an applicant located in a country different from the inventor country. Co-invention: share of patents in total inventions worldwide having at least two inventors located in different countries. Co-ownership: share of patents where at least two co-applicants are located in different countries (in total inventions worldwide).
Source: OECD, Patent Database May 2006.

Figure 7.2. Foreign ownership in domestic inventions



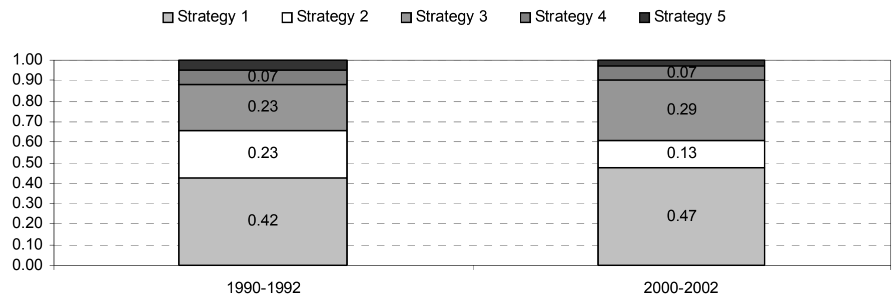
Note: Patent counts are based on the priority date and the inventor's country of residence, using simple counts; Share of patent applications to the European Patent Office (EPO) owned by foreign residents in total patents invented domestically.
Source: OECD, Patent Database May 2006.

Figure 7.3. Domestic ownership of inventions made abroad



Note: Patent counts are based on the priority date and the applicant's country of residence, using simple counts. Share of patent applications to the European Patent Office (EPO) invented abroad in total patents owned by country residents.
Source: OECD, Patent Database May 2006.

Figure 7.3. Composition of cross-border ownership in PCT applications



Note: Fractional counts of patent applications filed under the Patent Co-operation Treaty (PCT) and designating the European Patent Office, by strategy and priority year.
Source: OECD Patent Database, May 2006.

CHAPTER 8

INDICATORS OF PATENT VALUE

8.1 Introduction

222. The notion of "patent value" has several different meanings. It can mean the economic, "private" value to the holder, defined as the discounted flows of revenue generated by the patent over its life. It can mean the "social" value of the patent, its contribution to the stock of technology of society. The two concepts are closely related, as the revenue generated should be commensurate to the technological contribution, but they are not identical as part of the social value is not appropriated by the patent holder (there are externalities): the published knowledge for instance can be used by other inventors, competitors, to improve on the initial invention.

223. In addition, one should distinguish between the value of the patent itself and the value of the underlying invention. The former comprises only the value added by the fact that the invention is patented – it is the difference between the value of the invention as it is patented and the value it would have had if it had not been patented. The latter refers to the technological content or 'quality' of the invention that is its contribution to the state of the art. An invention with a significant contribution to the state of the art will then impact future technological developments. The two notions differ to the extent that the patent improves the appropriability of the benefits of certain inventions more than others.[64] Yet the capacity of patents to ensure appropriability of the income generated by inventions is known to differ, for instance, across technical fields.

224. Such considerations show that the value of a patent is a complex notion: it is necessary, however, to take it into account when thinking of patent statistics aimed at reflecting technological performance. All studies investigating the value either of patented inventions or of patent protection have shown that their statistical distribution is quite skewed; while some patents have high value, many others have little value (*e.g.* they are not exploited). As a result, patent counts, which give the same weight to all patents, can be misleading: a count of 100 patents can reflect various technological performances depending on its composition in terms of high-value vs. low-value patents. If one has information on the value of patents, there are two ways of accommodating this problem in indicators: one solution is to compile weighted counts, with the value as a weight; the other solution is to count only patents of sufficient value, ignoring the rest.

64 Inventions with high technical value might be widely appropriable (*e.g.* because a patent is easy to circumvent in the particular field of technology the invention belongs to). Inventions with small technical value could generate high economic value, *e.g.* if the inventor, for various reasons, already has a monopoly position on the market.

225. One difficulty in estimating the value of a patent is timeliness, *i.e.* to have reliable indicators reflecting the economic or technological value of an invention early enough so that they can be used as an indicator to assess the recent position of a company or a country (in the patent value landscape). Three main lines of work have been followed by researchers to estimate or infer the private economic value of patents:

- Conducting surveys asking inventors (holders) about the economic value of their patents (*e.g.* Scherer *et al.*, 1999).
- Estimating value from financial data (*e.g.* market value of companies, the value of initial public offerings, etc., Hall *et al.*, 2005)
- Analysing data from the patenting procedure (*e.g.* grant or refusal of the application, citations, renewal, geographical scope of protection, etc.)

226. In the first methodology, patent holders or inventors are asked for the monetary value of their patents (the price at which they would be willing to sell the invention, including the revenues that the patent will generate in subsequent years).[65] A patent can generate economic returns in different ways: exploitation in-house, through licensing, "strategic use" (to block others or to exchange technology), etc. The second approach involves the econometric estimation of the contribution of individual categories of patents or patent portfolios, to the economic performance of companies (*e.g.* stock market valuations, spin-off creations, etc.).

227. The third approach attempts to cast more light on the value of patents by using patent information mainly provided by bibliographic data (contained in publications, search and examination reports, opposition, etc.) which might be correlated with the value of patents. In this approach, indicators that have been consistently found as good predictors of value include the number of forward patent citations, the fact that the patent has been granted or not, patent oppositions or litigation, renewals, and family size.

228. This chapter reports major findings of the third approach. It aims at indicating possible avenues for patent statistics which would control for the dispersion of the value of patents, hence gaining relevance in economic terms. This area of work is largely still at the research stage, and many of the results reported in this chapter are debated among experts. It is, however, important for the design and interpretation of patent indicators to have value issues in mind.

229. Using proxies of patent value, patent-based indicators can be compiled which are less affected by the skewed value distribution of patents:

- Weighted counts: weight the count of patents by: the number of forward citations; the number of family members, etc.
- Counts of selected patents (dropping lower value patents): triadic families; highly cited patents (top 10% of the distribution); grants (instead of applications); patents renewed until some age (*e.g.* five years); etc.

8.2 Forward citations

230. The prior art of the invention (patent and non-patent literature) cited in patent documents provide useful information about the diffusion of technologies (see Chapter 6 on the use of citations). The number of citations a patent application receives in subsequent patent applications called 'forward citations' has

65 The merit of this approach is to gather information directly from the source. However, it might be subject to biases, as the inventor or the patent owner might not have, or might not be willing to provide accurate information.

been found to be strongly associated to the economic value of patents (Scherer *et al.*, 1999) and social value of inventions (Trajtenberg, 1990). The number of forward citations is one of the most frequently used value indicators.

231. Two main arguments support the validity of forward citations as indicators of patent value: first, they indicate the existence of downstream research efforts, suggesting that money is being invested into the development of the technology at stake (and there is a potential market); and second, the fact that a given patent has been cited by subsequent patent applications suggests that it has been used by patent examiners to limit the scope of protection claimed by a subsequent patentee, to the benefit of the society. In this sense, forward citations indicate both the private and the social value of inventions.

232. Nevertheless, the main difficulty in computing forward citations is that they appear over time, and sometimes a long while after the cited patent was filed, granted or even reached full term. For the sake of relevance it is important to ensure the timeliness of indicators. One remedy to this problem consists in counting citations received by patent applications within a given time window (*e.g.* within the first five years of their publication).

233. A common approach used to count forward citations is as follows: $CIT_{i,T} = \sum_{t=P_i}^{P_i+T} \sum_{j \in J(t)} C_{j,i}$ where $CIT_{i,T}$ is the number of forward citations received by patent application i published in year P_i within T years from its publication. $C_{j,i}$ is a dummy variable which is equal to 1 if application j is citing application i, and 0 otherwise. $J(t)$ is the set of all applications published in year t. A time window frequently used is five years after publication of the cited patent, as it has been calculated with USPTO patents that more than 50% of the citations received in an entire life of a patent occurred within the first five years.[66]

8.3. Indicators based on procedural information and applicants' behaviour

234. Information on the value of patents can be inferred using data from the patent application process (notably the fate of a patent application: withdrawal, refusal or grant) and applicants' behaviour in terms of survival span of patents (renewal rates) and the geographical scope of protection (*e.g.* the number of jurisdictions where patent protection has been sought, the number of international patent families; see Chapter 3).

8.3.1 The fate of the patent application

235. A first indicator on the quality of an invention is whether a patent results in a grant or not. A granted patent corresponds to an invention which is officially recognised as fulfilling the patentability criteria: novelty, inventive step (non-obviousness) and industrial applicability. Granted patents are then of higher technological and economic value than unsuccessful patent applications.[67] Pending applications may have some value on the market as they signal potential rights that may be enforced retroactively once granted. For instance, the European Patent Convention says that a published patent application provisionally confers upon the applicant the same rights in all designated states as that in which the patent was granted.

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66 Lanjouw and Schankerman (1998) suggest that limiting the time period subsequent to a patent's issuance to five years is sufficient to construct meaningful measures of a patent's "importance" based on "forward" citations

67 However, the grant is not always a good indicator. For instance, a better knowledge of the European system can contribute to higher grant rates of EP countries compared to US applicants at the EPO (Hinze and Schmoch, 2004).

236. The USPTO used to publish granted patents only, and all patents used for indicators would then be similar from that perspective. However, as most indicators are now based on applications, not grants, one has to be aware of this source of heterogeneity: some of the applications counted have been/will be granted, others have/will not be granted. The benefit in using applications is notably in terms of timeliness, as grant or refusal is made years after the application.

237. By analysing characteristics of the patent application (*e.g.* type of ownership, number of inventors; domestic and international co-operation, technology class, date of priority or application, etc.) one can identify probabilistically factors underlying the refusal, withdrawal or grant of patent applications (see Guellec and van Pottelsberghe de la Potterie, 2000).[68]

Table 8.1. Main indicators of patent value discussed in the literature

Indicator	**Rationale**	**Main limitations**
Granted	Limited legal protection if not granted; check by examiners	Not very informative (large share: about 60% of patent applications are granted). USPTO: 95% of patents are granted
Forward citations	Technological importance of inventions; impact on further technology developments	Timeliness (availability over time), interpretation
Family size (number of jurisdictions)	Costly to have protection in different jurisdictions. Sign of market potential of an invention	Representativity issues; large share of patent applications are international
Number of inventors	Proxy the cost of an invention (cost of research)	Rough measure which treats inventors equally; need for complementary information on the inventors (*e.g.* careers, patenting, etc.)
Renewals	Cost of maintaining a patent; renewal rates allows estimation of the distribution of value	Timeliness, influence of technology life cycles, renewal rates different across technologies (different value)
Opposition	Market value of a patent. Costs and risks associated with legal disputes	Timeliness, very small share (about 5% in EPO); how to detect mutual settlements
Litigation	Costs and risks associated with legal disputes	Timeliness, very small share, friendly settlements are frequent, data availability
Firm market value, spin offs, etc.	Patent value embedded as intangible asset	Selected type of companies (stock markets, etc.)
Surveyed economic value	Patent value known by inventors or managers	Subjectivity, selection issues, limited samples

Source: Modified from V. Zeebroeck (2007).

68 Some works suggest (*e.g.* Reitzig, 2004; Burke and Reitzig, 2007) that a “request for accelerated examination” at the EPO (similar procedures exist at the JPO and USPTO) may signal high-value inventions for which the owner wants protection as soon as possible.

8.3.2 Renewal of patents

238. Data on the renewal of patents and the family size (commonly defined in the economic literature as the number of countries where protection has been sought; see Chapter 5 for definitions of patent families) have been widely used to draw inferences on the value of patents. Studies in this field exploit the fact that it is expensive to holders to maintain patent protection for an additional period of time and in additional countries. Hence it is hypothesised that the value of continuing patent protection in time and expanding it in space is associated to the economic importance of the invention. Not surprisingly, the two types of indicators have been found to be highly correlated.

239. In most patent systems, patent holders must pay a periodic fee in order to keep their patents in force. Typically, the renewal fee increases over time and at the end of every period, patent holders are confronted with the decision to renew or not. Failure to do so results in the lapse of the patent, which releases the invention into the public domain. Observations of the proportion of patents that are renewed at different ages, together with the relevant renewal fee schedules, provide information on the distribution of the value of patents and the evolution of this distribution over the lifespan of a patent (Griliches, 1990).

240. The rationale behind this approach is based on economic criteria. Patents are renewed only if the value of keeping the patent alive (based notably on the discounted expected stream of profits) is higher than the cost of renewing the patent. Hence, when the renewal fee is not paid, the patent has expected returns (in future periods) lower than the threshold. As the fees increase over time in most countries, patentees must consider the profitability of renewing for the following period during the current period (the protection 'option', Lanjouw and Schankerman, 1997) against the costs of maintenance. It is usually difficult for holders to know the expected returns of a patent. Frequently, it takes some time to learn the market potential of inventions as the decision to patent is frequently made at earlier stages of the innovation process.[69] In some countries (*e.g.* Japan, United States), the renewal fees for the patents granted to universities and small and medium-sized enterprises (SMEs) as well as government entities may be reduced as a preferential treatment.

241. The different investigations in this field have confirmed the highly skewed distribution of patent values, with a median far below the mean. According to Pakes and Schankerman (1986), half of the estimated value belonged to about 5% of the entire patent population analysed.[70] In a study of renewal of patents in Finland and Norway, Pakes and Simpson (1989) found that patents in the pharmaceutical sectors and the lumber, wood and paper sector had the highest renewal rates, followed by patents for inventions in the machinery sector, the chemical sector, food products and the primary metals sector.

242. There are a number of limitations to the patent renewal approach. The results of these studies rest on assumptions regarding the functional form of the relationship and on unobserved value of the most valuable patents – those which are renewed to full statuary term ("open-ended"). In some cases, patent drops might not be indicative of low value but rather a change in a company's strategy, related for instance to an external shock. In technologies that change rapidly, many inventions are of high value when

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69 There are compelling facts about this behaviour that show that only few patents are renewed through the end of their term. For instance, Pakes and Schankerman (1986) found that only 10% of all patents survive the entire renewal period. According to Lemley (2001), using renewal data for United States patents in 1998, nearly two-thirds of all issued US patents lapse before the end of their term due to failure to pay renewal fees, and nearly half of all patents are abandoned before their potential lifespan is half over.

70 Pakes (1986) explained that the stream of revenues behaves differently along the cycle of patent protection and earlier years of the patent are frequently characterised by a high level of economic uncertainty. As learning about the profitability of the invention increases, the uncertainty gradually fades away when patents reach a certain age threshold -- between four and five years, *e.g.* Pakes (1986) and Lanjouw (1998).

introduced but can become obsolete shortly thereafter. Exogenous factors might also influence the decision to renew patents. For instance, Schankerman (1998) finds evidence of oil shocks in French patent renewal data.[71] Finally, the time profile of revenues might depend upon the technical field and other characteristics of the invention; inventions are obsolete more rapidly in electronics than in pharmaceuticals.

Table 8.2. Shares of countries in total patent applications under different indicators (priority date 2000)

	PCT	Triadic	EPO	PCT most cited
Canada	0.02	0.01	0.01	0.01
France	0.05	0.05	0.06	0.06
Germany	0.13	0.13	0.19	0.17
Japan	0.10	0.31	0.19	0.17
Netherlands	0.03	0.02	0.03	0.03
United Kingdom	0.06	0.03	0.05	0.05
United States	0.40	0.33	0.27	0.31
World	1.00	1.00	1.00	1.00

Note: Criteria for counting are country of residence of inventor(s) and priority date. PCT patent applications at international phase, designating the EPO; EPO are Direct EPO filings plus EURO-PCT in regional phase, and triadic patent families are a subset of patents all filed together at the EPO, at the JPO and granted by the USPTO (protecting the same set of inventions; same priority date). PCT most cited are PCT patent applications at the international phase (designating the EPO) which are amongst the most highly cited (at the top 10 percentile). Data on triadic patent families are mainly derived from PATSTAT.

8.3.3 Patent family size

243. The value of patents is also associated with the geographical scope of patent protection; that is, to the number of jurisdictions in which a patent grant has been sought (see Chapter 4 for definitions of patent families). The fact of applying for patent protection abroad already constitutes a sign of economic value, as such a decision reflects the owner's willingness to bear the costs of international patent protection. The rationale behind this is closely related to the decision to renew a patent; it is costly to make a patent valid in more than one country (as it implies applying for a patent directly or indirectly via regional or international offices) and to maintain the protection (Putnam, 1996).

244. In contrast with the data on renewal which is available over time (or data on forward citations, see Chapter 6), the number of countries where protection is sought is available earlier in time (one year priority right according to the Paris convention). This is an advantage of this source of information, allowing the construction of indicators early in the life of a patent application.

245. The geographical scope of protection, as reflected in international patent grants for a given invention, reflects the *market coverage* of an invention: the higher the number of countries where protection has been sought, the greater the potential for commercialisation and profits.[72] There is consistent evidence that the family size reflects economic value. For instance, Lanjouw and Schankerman (2004) find a strong positive relationship between a quality index of patents and the family size (in a sample of US patents). Guellec and van Pottelsberghe de la Potterie (2000) report a positive association between the family size and the likelihood that a European patent obtains a grant. Harhoff *et al.* (2003) provide evidence that patents taking part of large international patent families are more strongly associated to

71 In the pharmaceutical industry, institutional factors such as the long regulatory delays between drugs development and their introduction to the market might make the renewal rates intrinsically higher than in other industries.

72 Measures of family size (or number of inventors) depend on the country of origin, *e.g.* the family size of European countries is always higher than that of Japanese applicants (due to the high number of European neighbour countries).

economic value. In the group of pharmaceuticals and chemicals, this indicator carries the highest coefficient of all technology-specific sets of results.

246. In the case of the European patent system, the list of EPC (European Patent Convention) countries where protection is sought is provided in the application. The payment of application fees to the EPO is dependent on this list, although the relationship has become flatter over time. For European and international applications filed on or after 1 July 1999 at the EPO, the designation fees are deemed paid for all contracting states upon payment of at least seven countries. In fact, under the EPC 2000, applications will be deemed to designate all available contracting states through a single flat designation fee (see Box 8.1). From April 2009, European patent applications designate all contracting states as in the PCT procedure.[73]

247. After grant, the family size of a European patent can be quantified as the number of EPC member states in which the patent was effectively validated once granted. The size of the EPC family can naturally reduce over time as patents are abandoned in different countries, hence the necessity to observe the geographical scope at different points in time. Information on the renewal and geographical scope of protection can be used to produce more refined indicators taking into account the evolution of protection over time across countries (as patents may lapse in some countries each year, see Box 8.2).

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73 Applying through PCT might already be seen as an indicator of inventions with higher market expectations. This indicator can be decomposed into PCT I and PCT II. Further insights can be obtained by looking at the time elapsed between two stages, *i.e.* if the period of time between filing date and entry into the regional phase is 20 months or less (PCT I) or exceeds 20 months (PCT II). One argument would be that the higher the applicant's willingness to pay for the delay of cost-intensive decisions during the application, the higher the applicant's uncertainty about the focal patent's commercial value (see Burke and Reitzig, 2007).

8.4 Other indicators

8.4.1 The number of claims

248. The scope of a patent is an important determinant of its economic value, as it defines the legal dimensions of protection and thereby the extent of market power attributed to the patent. A broader scope refers to a broader area of technology space from which others are excluded.

249. However, the 'scope' or 'breadth' of a patent is difficult to operationalise and measure. The scope of a patent is reflected in the claims, but it operates in conjunction with the backward patent citations

Box 8.1. Reforms concerning the designation of states

When computing indicators on the size of geographical protection based on states designated in EPO and PCT applications, it is important to know that these indicators will not longer be relevant as indicators of market coverage as procedures at the PCT and EPO have converged towards automatic designation (all contracting states) with a single flat fee. It is important to know then when these reforms are taking place when working with time series of patent data:

- **Designation in the Patent Cooperation Treaty**

  For international applications having an international filing date on or after **1 October 1998**: for the first 11 national or regional offices designated there is a designation fee per country or region. There is no additional charge for each designation in excess of 11 offices. From April 2009, European patent applications designate all contracting states as in the PCT procedure.

  For international applications having an international filing date on or after **1 January 2004:** the filing of an international application request constitutes the designation of all contracting states that are bound by the Treaty on the international filing date.

- **Designation at the EPO**

  Since **1 July 1999** and applicable to European and international applications entering the regional phase (filed on or after this date), each designated contracting state is subject to a designation fee up to seven designated states. There is no additional fee for designation in excess of seven offices.

  As of **1 April 2009:** Automatic designation of contracting states under a single fee. A flat fee will be charged regardless of the number of designated contracting states. This decision applies to European patent applications filed on or after 1 April 2009 as well as to international applications entering the regional phase on or after that date.

–which define the legal boundaries of the patent with respect to previous art.[74] A number of economists have used the *number of claims* to proxy the legal scope of patents. It has been argued that, as each individual patent represents a bundle of inventive components, each reflected in a claim, the number of claims could be indicative of the value of the entire patent. Nevertheless, the tendency of certain applicants

74 As evidenced in the interviews with patent lawyers and examiners, a patent application seeking to protect an invention with broad scope might induce the examiner to delineate the patent claims by inserting more references to the relevant patent literature. Backward citations in this sense also reflect the scope of a patent as well as the existence of subject matter that may restrict the scope of the patent (Harhoff *et al.*, 2003).

to 'inflate' the number of claims for strategic purposes makes the relationship between scope and number of claims quite noisy. The number of claims is also subject to special rules and fees, which could weaken its relation with the value of the invention. In addition, it is important to mention that in granted patents, the claims that appear result after examination.

Box 8.2. A combined indicator (European protection): the scope year index

Data on the interaction of the renewal and the geographical scope of protection of a patent can be used to produce a more refined index taking into account the evolution of geographical protection over time (as patents may lapse in some countries each year. This indicator can reflect both the age reached and the European family size (van Pottelsberghe and van Zeebroeck, 2007):

$$SY_{CT,i} = \frac{\sum_{t=1}^{T}\sum_{c=1}^{C} G_i(c,t)}{CxT}$$

Where $SY_{CT,i}$ stands for the scope year (SY) index of a given patent i over C countries and T years of maintenance, and $Gi(C,t)$ is a variable that takes the value 1 if the granted patent i was active in country c in year t from its filing date, and 0 otherwise. The index is normalised to its maximum value representing T years of maintenance in C countries. This way, the indictor sums for each year in a patent life the number of countries in which the patent was active in Europe. To enable the comparability of the indicator over time and to ensure its availability within ten years from the date of filing, the indicator proposed by the authors was based on ten countries over ten years. This allows overcoming the institutional bias to family sizes (the institutional expansion of the EPC, from ten countries in 1977 to 32 in 2007).

Extensions of this indicator can consider weighing validation in jurisdiction by their economic importance, for instance, by the magnitude of their GDP. Note that as such, the SY index score of non-granted applications is necessarily zero, since patents can be validated in EPC member states only once granted by the EPO. A provisional version of the SY index has been proposed, taking into account the duration of the grant procedure (the number of years during which the application has been maintained). See van Pottelsberghe and van Zeebroeck (2007) for further details about this formulation.

250. Empirical analysis on this matter is scarce but quite positive. In their factor model of patent quality to analyse research productivity in the United States, Lanjouw and Schankerman (2004) found that the number of claims was the most important indicator of the quality of patents in six out of the seven technological fields. It has also been found that the likelihood of a patent being litigated, which reflects its scope, increases with its number of claims (Lanjouw and Schankerman, 1997).

8.4.2 The number of technical classes

251. The number of technical classes (as indicated by the number of IPC classes) attributed to a patent application has also been used as a proxy for the scope, hence the value, of a patent. This approach was proposed by Lerner (1994) in a study of market value of biotechnology patents as a measure of the value of the respective patent portfolio. He finds a positive and sizable correlation between the firm's market value and the average scope of its patents.

252. However, there is limited evidence of a correlation between the number of classes and the value of a patent. Lanjouw and Schankerman (1997) find a small positive effect of the number of IPC classifications on the probability of infringement litigation in US patents. Using information from a survey

on the perceived economic value of patents by German inventors, Harhoff *et al.* (2003) did not find the number of four-digit IPC classes informative of the patent value in any of the technology fields analysed.[75]

8.4.3 The number of inventors in a patent

253. Several economic studies have associated the number of inventors listed in a patent to the value of patents, both economical and technological. The number of inventors might proxy the cost of the research behind the invention, which itself is statistically related to the technical value of the invention: the more resources involved, the more research-intensive and expensive the project is (Guellec and van Pottelsberghe, 2001; Gambardella *et al.*, 2003).

8.4.4 Opposition and litigation

254. Certain patent offices offer the possibility for third parties to oppose granted patents that they deem invalid. As opposing a patent is a costly move, it can be inferred that only patents with some damaging effects on competition, hence some economic value, will be opposed. Hence the fact that a patent is opposed can be interpreted as a signal of value. Further, patents surviving opposition are then proven strong patents with high profitable prospects to their holders.

255. Only few patents are opposed. In 2006, the opposition rate at the EPO was around 5.4% (oppositions were filed against 2 990 patents). From opposed patents at EPO, roughly one-third are revoked, one-third are maintained unchanged, and one-third are maintained amended. At the USPTO, interested parties wishing to challenge a U.S. patent after its issue have two options: *i)* challenge the patent in federal court; or *ii)* request a “re-examination” of the patent by the USPTO. The opposition rate at the EPO is much higher than the re-examination rate at the USPTO for all technology classes (Merges, 1999; Graham *et al.,* 2002). The rate of re-examination at the USPTO between 1981 and 1998 was of 0.3% (of grants), whereas at the EPO, the opposition average rate during the same period was 8.6% of grants. However, in absolute terms, patent litigation grew significantly in the United States from 1985 to 2000, although the rate of litigation relative to the number of issued patents has remained constant (ibid).

256. Some authors have found that opposed and litigated patents are of higher value than the average. Harhoff *et al.* (2003) find that successful defense against opposition (in the German patent system) is a particularly strong predictor of patent value.[76] They explain that stronger patent rights survive amounting to a two-tiered selection process (grant and survival of opposition), which provides a highly reliable indicator of their quality. According to Lanjow and Schankerman (1998), patents that are litigated have particular characteristics. Compared to a random sample of US patents from the same cohorts and technology areas, the authors find that more valuable patents and those with domestic owners are considerably more likely to be involved in litigation. Patents owned by individuals are at least as likely to be the subject of a case as corporate patents and litigation is particularly frequent in new technology areas.

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75 The authors explained that the difference in results may be due to the use of patents which cover a broad set of technical areas, while Lerners’ study focuses only on biotechnology patents. They also pointed out that there may also be important differences in the way the German and the US Patent Offices assign the IPC classification.

76 They find that a patent which has defeated opposition in Germany *(“Einspruchsverfahren”)* is considerably more valuable – as measured by the monetary value of inventions estimated by inventors (by a factor of 11.2) – than a patent that was never attacked. Further, if the patent has been under attack in the more expensive annulment procedure, its value is again much higher than the value of unchallenged patent rights, in this case by a factor of 42.6.

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GLOSSARY

Appeal: A procedure by which the applicant or patent holder can request reversal of a decision taken by the patent office.

- *USPTO:* An applicant for a patent dissatisfied with the primary examiner's decision in the second rejection of his or her claims may appeal to the Board for review of the examiner's rejection. The Board of Patent Appeals and Interferences (BPAI) is a body of the United States Patent and Trademark Office (USPTO) that reviews adverse decisions of examiners in patent applications and determines priority and patentability of invention in interferences. Decisions of the board can be further appealed to the Court of Appeals for the Federal Circuit (CAFC) or to a district court.

- *EPO:* Decisions of the first instances of the EPO can be appealed before the Boards of Appeal of the EPO, in a judicial procedure (proper to an administrative court), as opposed to an administrative procedure. These boards act as the final instances in the granting and opposition procedures before the EPO. In addition to the Boards of Appeal, the European Patent Office includes an Enlarged Board of Appeal. This instance takes decisions only when the case law of the Boards of Appeal becomes inconsistent or when an important point of law arises.

- *JPO:* an applicant who receives a rejection can appeal. The panels consist of three or five trial examiners in the Appeals Department of the JPO. Decisions of the panels can be further appealed to the Intellectual Property High Court, a special branch within the Tokyo High Court.

Applicant: The holder of the legal rights and obligations on a patent application. It is most often a company, a university or an individual.

Application date: The date on which the patent office received the patent application. A unique number is assigned to a patent application when it is filed.

Assignee: In the United States, the person(s) or corporate body to whom all or limited rights under a patent are legally transferred by the inventor (equivalent to "applicant" in this context).

Citations: References to the prior art in patent documents. Citations may be made by the examiner or applicant. They comprise a list of references that are believed to be relevant prior art and which may have contributed to defining the scope of the claims of the application. References can be made to other patents, to technical journals, textbooks, handbooks and other sources. *USPTO:* Applicants before the USPTO are required to disclose prior art known to them that is material to patentability; *EPO:* No such obligation for the applicant; *JPO:* The requirement for disclosure of information on prior art documents was introduced as of 1 September 2002 and entered into full force on 1 May 2006.

Claim(s): Definition of the scope of the invention and the aspects of the invention for which legal protection is being sought.

Continuation(s) *(USPTO)***: S**econd or subsequent applications for the same invention claimed in a prior non-provisional application and filed before the first application is abandoned or patented. Continuations must claim the same invention as the original application to gain the benefit of the parent filing date. There are three types of continuing applications: division, continuation and continuation-in-part.

Designated countries: In international and regional patent systems, countries in which patent applicants wish to protect their invention if/when the patent is granted. International application filing automatically includes the designation for all PCT contracting countries that are bound by the PCT treaty on the international filing date (since 2004). A similar rule will apply to EPO from April 2009, as European patent applications designate all contracting states as in the PCT procedure.

Direct European route (application): A patent application filed under Article 75 EPC (also known as "Euro-direct application"). With the direct European route, the entire European patent grant procedure is governed by the EPC alone while with the Euro-PCT route, the first phase of the grant procedure (the international phase), is subject to the PCT.

Division: If the patent office decides that an application covers too broad an area to be considered as a single patent, then the application is split into one or more divisional applications, which might be pursued or not by the applicant. A division can also be requested at the initiative of the applicant.

Equivalent: A patent that protects the same invention and shares the same priority application as a patent from a different issuing authority.

Euro-PCT route: A way to obtain a European patent by designating the EPO in a PCT application (Article 11 PCT). The first phase of the grant procedure (the international phase) is subject to the PCT, while the regional phase before the EPO as designated or elected office is governed primarily by the EPC.

- **Euro-PCT application – international phase (or Euro-PCT application or PCT international).** A PCT application designating the EPO (Article 150(3) EPC); while with the Euro-PCT route, the first phase of the grant procedure (international phase) is subject to the PCT, the regional phase before the EPO as designated or elected office is governed primarily by the EPC.

- **Euro-PCT application – regional phase (or PCT regional)**: PCT application entering the European (or regional) phase once the applicant has fulfilled the conditions under Article 22 or 39 PCT, Article 158 and Rule 107 EPC.

Euro-PCT search (or PCT Chapter I): Search carried out by the EPO acting as International Searching Authority for a Euro-PCT application in the international phase (Article 16 PCT).

European patent: A European patent can be obtained for all the EPC countries by filing a single application at the EPO in one of the three official languages (English, French or German). European patents granted by the EPO have the same legal rights and are subject to the same conditions as national patents (granted by the national patent office). It is important to note that a granted European patent is a "bundle" of national patents, which must be validated at the national patent office in order to be effective in Member countries. The validation process could include submission of a translation of the specification, payment of fees and other formalities of the national patent office (*i.e.* once a European patent is granted, competence is transferred to the national patent offices).

European Patent Convention (EPC): The Convention on the Grant of European Patents) was signed in Munich 1973 and entered into force in 1977. It is a multilateral treaty instituting the European Patent Organisation and providing an autonomous legal system according to which European patents are granted. The EPC provides a legal framework for the granting of European patents, via a single, harmonised procedure before the European Patent Office. It enables the patent applicant, by means of a single procedure, to obtain a patent in some or all of the contracting states. As of January 2008 there are 34 EPC member countries. In addition, extension agreements exist with five countries, offering the possibility to extend European patents to those countries upon request. EPC member countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom. EPC extension countries are Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, and Serbia.

European Patent Office (EPO): The European Patent Office (a regional patents office) was created by the EPC to grant European patents, based on a centralised examination procedure. By filing a single European patent application in one of the three official languages (English, French and German), it is possible to obtain patent rights in all the EPC member and extension countries. The EPO is not an institution of the European Union.

Family: a set of patents (or applications) filed in several countries to protect the same invention. They are related to each other by one or several common priority numbers. There are different definitions of patent families (*e.g.* triadic patent families, extended families including continuations, etc.). Depending on what use is sought, a different family concept can be chosen, *e.g.* equivalents, triadic family or trilateral family.

First to file: A patent system in which the first inventor to file a patent application for a specific invention is entitled to the patent. This law is increasingly becoming the standard for countries adhering to the Trade-Related aspects of Intellectual Property (TRIPs) guidelines. In the EPO and the JPO. patents are awarded on the first to file basis, whereas in the USPTO patent is awarded on the first to invent basis.

First to invent *(USPTO)***:** A system in which a patent is awarded to the first person who made the invention, even if another person filed for a patent before the person who invented first.

Grant: A patent application does not automatically give the applicant a temporary right against infringement. A patent has to be granted for it to be effective and enforceable against infringement.

Grant date: The date when the patent office issues a patent to the applicant.

Infringement: Unauthorised use of a patented invention.

Intellectual property rights (IPR): The exclusive legal rights associated with creative work, commercial symbols or inventions. There are four main types of intellectual property: patents, trademarks, design, and copyrights.

International patent application: See "PCT application". A patent application filed under the Patent Cooperation Treaty (PCT) is commonly referred to as an "international patent application". However, international patent (PCT) applications do not result in the issuance of "international patents" (*i.e.* at present, there is no global patent system that issues and enforces international patents). The decision of whether to grant or reject a patent filed under PCT rests with the national or regional (*e.g.* EPO) patent offices.

International Patent Classification (IPC): The IPC is based on an international multilateral treaty administered by WIPO. The IPC is an internationally recognised patent classification system, which provides a common classification for patents according to technology groups. The IPC is a hierarchical system in which the whole area of technology is divided into eight sections broken down into classes, subclasses and groups. IPC is periodically revised in order to improve the system and to take account of technical development. The eighth edition of the IPC entered into force on 1 January 2006.

International Searching Authority (ISA): An office with competence to carry out the international search for a PCT application. It may be either a national office (Australia, Austria, Canda, China, Finland, Japan, Korea, Russian Federation, Spain, Sweden, United States) or an intergovernmental organisation (EPO), (Article 16 PCT, Article 154 EPC).

Inventive step: At EPO and JPO, an invention is considered to include an inventive step if it is not obvious to a person skilled in the art. Inventive step is one of the criteria (along notably with novelty and industrial applicability) that need to be fulfilled in order to obtain a patent. See also "non-obviousness" *(USPTO)*.

Inventor country: Country of residence of the inventor.

Japan Patent Office (JPO): The JPO administers the examination and granting of patent rights in Japan. The JPO is an agency of the Ministry of Economy, Trade and Industry (METI).

Lapse: The date when a patent is no longer valid in a country or system due to failure to pay renewal (maintenance) fees. Often the patent can be reinstated within a limited period.

Licence: The means by which the owner of a patent gives permission to another party to carry out an action which, without such permission, would infringe on the patent. A licence can thus allow another party to legitimately manufacture, use or sell an invention protected by a patent. In return, the patent owner will usually receive royalty payments. A license, which can be exclusive or non-exclusive, does not transfer the ownership of the invention to the licensee.

National application: A patent application that is filed at a national patent office according to a national procedure.

Novelty: An invention cannot be patented if certain disclosures of the invention have been made.

Non-obviousness *(USPTO)*: Something is obvious if the differences between the subject matter to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skills in the art to which said subject matter pertains. See also "inventive step" *(EPO, JPO)*.

Opposition: This is a procedure usually before the issuing patent office, initiated by third parties to invalidate a patent.

- *EPO:* Opposition to the grant of a European patent can be filed within the nine months of the mention of the grant in the European Patent Bulletin.

- *JPO:* Opposition to a grant could be filed within the six months of the issue of the grant before the reform of appeals for invalidation was introduced in January 2004.

Paris Convention: The Paris Convention for the Protection of Industrial Property was established in 1883 and is generally referred to the Paris Convention. It established the system of priority rights, under which applicants have up to 12 months from first filing their patent application (usually in their own country) in which to make further subsequent applications in each signatory country and claim the original priority date. There are 172 countries party to the treaty (March 2008).

Patent: A patent is an intellectual property right issued by authorised bodies which gives its owner the legal right to prevent others from using, manufacturing, selling, importing, etc., in the country or countries concerned, during up to 20 years from the filing date. Patents are granted to the inventor in the United States and to firms, individuals or other entities as long as the invention satisfies the conditions for patentability: novelty, non-obviousness and industrial applicability.

Patent Cooperation Treaty (PCT): As of March 2008, there were 138 countries party to the treaty, which was signed in 1970 and entered into force in 1978, enabling a patent applicant, by means of a single procedure, to obtain a patent in some or all of the contracting states. The PCT provides the possibility to seek patent rights in a large number of countries by filing a single international application (PCT application) with a single patent office (receiving office). PCT applications do not result in the issuance of "international patents". The decision on whether to grant or reject patent rights rests with national or regional patent offices. The PCT procedure consists of two main phases: *(a)* an "international phase"; and *(b)* a PCT "national/regional phase". PCT applications are administered by the World Intellectual Property Organisation (WIPO).

PCT international search: A search carried out by a designated office (international searching authority) for PCT applications.

Pending application: An application has been made at the patent office, but no decision has been taken on whether to grant or reject the patent application

Prior art: Previously used or published technology that may be referred to in a patent application or examination report. *(a)* In a broad sense, technology that is relevant to an invention and was publicly available (*e.g.* described in a publication or offered for sale) at the time an invention was made, *(b)* in a narrow sense, any such technology which would invalidate a patent or limit its scope. The process of prosecuting a patent or interpreting its claims largely consists of identifying relevant prior art and distinguishing the claimed invention from that prior art. The objective of the search process is to identify patent and non-patent documents constituting the relevant prior art in order to determine whether the invention is novel and includes an inventive step.

Priority country: Country where the patent is first filed worldwide before being extended to other countries. See “Paris Convention”.

Priority date: The priority date is the first date of filing of a patent application, anywhere in the world (usually in the applicant’s domestic patent office), to protect an invention. Priority date is used to determine the novelty of the invention, which implies that it is an important concept in patent procedures. Priority date is the closest date to the date of invention.

Priority rights: see “Paris Convention”.

Processing time: Duration of a process in the patent procedure (*e.g.* search, examination, grant, and possible opposition and appeal).

Publication: In most countries, a patent application is published 18 months from the priority date.

- *EPO:* All patent applications are published in this manner, whether the patents have been granted or not.
- *JPO:* the patent applications that are no longer pending in the JPO, *e.g.* granted, withdrawn, waived or rejected, are not published. While official patent gazettes are only published in Japanese, the abstracts and bibliographic data of most of the unexamined patent applications are translated into English, and are published as the Patent Abstracts of Japan (PAJ).
- *USPTO:* Prior to change in rule under the American Inventors Protection Act of 1999, USPTO patent applications were held in confidence until a patent was granted. Patent applications filed at the USPTO on or after 29 November 2000 are required to be published after 18 months from the priority date. However, there are certain exceptions for the publication of pending patents. For example, an applicant can ask (upon filing) for the patent not to be published by certifying that the invention disclosed in the application has not and will not be the subject of an application filed in another country. Also, if the patent is no longer pending or subject to secrecy order, then the application will not be published.

Renewal fees: Once a patent is granted, annual renewal fees are payable to patent offices to keep the patent in force. In the USPTO they are referred to as “maintenance fees”. In most offices, renewal fees are due every year. USPTO-granted (utility) patents are subjected to maintenance fees which are due three-and-a-half years, seven-and-a-half years, and eleven-and-a-half years from the date of the original patent grant.

Request for examination: Patent applications filed at the EPO and JPO do not automatically enter the examination process. The applicant has to submit a request for examination within six months of the transmission of the search report at the EPO, and within three years of filing at the JPO. Patent applications filed at the USPTO are automatically examined by a patent examiner without the need for a separate request by the applicant.

Revocation: a patent is revoked if after it has been granted by the patent office, it is deemed invalid by a higher authority (appeal body within the patent office or a court).

Search report: The search report is a list of citations of all published prior art documents which are relevant to the patent application. The search process, conducted by a patent examiner, seeks to identify patent and non-patent documents constituting the relevant prior art to be taken into account in determining whether the invention is novel and includes an inventive step.

Triadic patent families The triadic patent families are defined at the OECD as a set of patents taken at the European Patent Office (EPO) and the Japan Patent Office (JPO) and granted by the US Patent & Trademark Office (USPTO) that share one or more priorities. Triadic patent families are consolidated to eliminate double counting of patents filed at different offices (*i.e.* regrouping all the interrelated priorities in EPO, JPO and USPTO patent documents).

Trilateral patent families: A trilateral patent family is part of a filtered subset of patent families for which there is evidence of patenting activity in all trilateral blocs. It is then similar to a triadic family, except that it would also include applications filed in any EPC state that do not go to the EPO (in addition to going to the JPO and USPTO). Trilateral patent families are usually counted in terms of individual priorities, without consolidation.

United States Patent and Trademark Office (USPTO): The USPTO administers the examination and granting of patent rights in the United States. It falls under the jurisdiction of the US Department of Commerce.

Utility model: This type of patent, also known as a "petty patent", is available in some countries. It usually involves a lower inventive step than that in a traditional patent, it is cheaper to obtain and it is valid for a shorter time period.

Withdrawal: Under the European Patent Convention, the applicant can withdraw his application at any stage of the procedure. He can do so by informing the office or by abstaining to do one or more of the following: pay fees in due time, file a request for examination within the given time period, or reply in due time to any communication within the examination procedure.

World Intellectual Property Organization (WIPO): An intergovernmental organisation responsible for the administration of various multilateral treaties dealing with the legal and administrative aspects of intellectual property. In the patent area, the WIPO is notably in charge of administering the Paris Convention, the Patent Cooperation Treaty (PCT) and International Patent Classification system (IPC).