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Patent indicators

Impact of international patent applications on patent indicators

Ulrich Schmoch

International patent applications, according to the Patent Co-operation Treaty, enjoy increasing popularity, as they provide various advantages for the applicants. The enormous growth of this type of application path has a relevant impact on patent statistics and therefore on patent indicators. The most problematic aspect is the delayed transfer of international applications to the national or regional office of destination, leading to an underestimation of recent application numbers. The article suggests a projection method compensating this effect in a reliable way.

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TECHNOLOGICAL CHANGE and innovation are important factors for productivity and competitiveness and have thus become a central topic of economic analysis in most industrialised countries. For analysing science and technology activities in quantitative terms, analysts employ various indicators such as R&D budgets, R&D personnel, production and foreign trade of technology-intensive goods, or technometric indexes.[1] Patents have proved to be further effective indicators which are increasingly used for studies in innovation. To introduce quality standards in their application, the OECD (Organisation for Economic Co-operation and Development) has published a special manual on patent indicators (OECD, 1994).

For the comparison of country or company performances using patent indicators, the choice of an appropriate framework is crucial. Therefore, patent statistics are generally computed from data of well-defined national or regional patent offices. However, these statistics are increasingly affected by international patent applications according to the Patent Co-operation Treaty (PCT), the number of which has enormously increased during the last decade.

The impact of PCT applications on national or regional patent systems is because after an initial international phase, they can be transferred to specific offices and become national or regional applications. Therefore, in statistics at specific patent offices, indirect applications through the PCT path have to be taken into account in addition to direct applications at the offices considered.

This paper investigates the impact of PCT applications on statistics at national and regional patent offices in order to provide appropriate patent indicators

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for economic and technological analysis. The focus of the article is on the situation at the European Patent Office (EPO), because this office has proved to be advantageous for international comparisons. Furthermore, the EPO plays a crucial role in the application and examination procedures of the PCT system.

PCT procedures

This section is based on an analysis of the legal literature, primarily manuals and textbooks, because only few relevant articles could be identified.[2] Furthermore, four outstanding experts in this area were interviewed.[3] We discuss the general structures of the PCT procedures to explain the enormous growth of PCT applications and to illustrate their impact on national and regional patent systems. This detailed description of the patent procedures is necessary to understand their specific impact on the set-up of patent indicators.

National, regional and international paths

In general, patent applications for an invention are first made at the domestic patent office, that is, in the country of the applicant. This first registration, which is quite close to the date of invention, is called priority application.[4] Because of this close relationship between invention and priority date, statistics for creating patent indicators should be based on priority years and not on the dates of subsequent applications, publications or grants, as the involved administrative procedures can distort the results. Indeed, Guellec and van Pottelsberghe (1998) showed by an econometric analysis that priorities are the most appropriate data for patent counts and are closely related to R&D investments.

According to the Paris Union Convention (PUC), the applicant can think about further related applications in foreign countries during one year, the so-called priority year. Until 1978, if the applicant decided to achieve additional protection in foreign countries, he/she had to file the follow-up applications directly at the designated foreign patent offices and had to pursue several foreign patent procedures in parallel.

The year 1978 was a remarkable turning point for the international patent system, as the EPO was opened and the international patent procedure according to the PCT came into force. As a result of this new ruling, an applicant can now file a central application at the EPO instead of many parallel applications at several national European patent offices. Then the application is examined in only one centralised procedure, and in case of a grant, it can be transferred to the designated national patent offices and becomes a regular national patent. So in the end, the patent protection refers to national territories and is decentralised. At present, up to 18 countries can be designated in the European patent procedure.

A further centralised path for achieving patent protection in several foreign countries is the international or PCT application. A PCT application is generally filed at the end of the priority year at the domestic patent office of the applicant, the World Intellectual Property Organisation (WIPO), or, in the case of European applicants, at the EPO. In the PCT application, the applicant can designate up to 95 countries.[5] If he/she designates the EPO instead of the direct designation of European countries, the application is called a Euro-PCT application.

In the first phase of the PCT procedure, called Chapter I, a copy of every application is sent to an International Searching Authority (ISA) to carry out the search as to the referring state of the art. International Searching Authorities are the EPO and the patent offices of the United States, Sweden, Japan, Australia, Russia, Austria, and recently, China and Spain. The EPO carries out more than half the searches, as it can be chosen as International Searching Authority by non-European applicants as well.

The PCT application is published, as at most patent offices in the world, 18 months after the priority application. At the same time, the applicant receives the result of the international search, so that he/she can assess the prospects of successfully achieving a grant. At this point, the applicant has the choice either to transfer the application to the designated national and regional offices and thus to enter the national or regional phase, or to elect an international preliminary examination. In that case, the national or regional phase entry deadline is deferred until the 30th month, in some territories even until the 31st month after the priority date.[6]

The stage of the preliminary examination is called Chapter II. The International Examining Authorities are the same as the International Searching Authorities. The results of the preliminary examinations are not legally binding for the designated national and regional offices. However, if the EPO is the International Examining Authority, the outcome of the preliminary examination is taken over into the regional EPO phase.

At the end of the PCT procedure, the applicant must decide to which of the originally designated offices the application shall actually be transferred. Then the national and regional offices carry out the legally binding examination and, in case of success, grant a patent. So again, the final outcomes are several parallel patent protections limited to specific national territories.

However, it should be kept in mind that the international, regional or combined Euro-PCT paths are only options. The applicant can still approach foreign offices directly without the mediation of the WIPO or the EPO. He/she can even follow the national, regional and international routes in parallel and only has to decide on one of these competing options in case of a grant decision of the EPO or a national authority. Alternatively, he/she can dispense with a first national application and directly submit the first application to

The transfer to national offices implies considerable cost, comprising official fees, payments to national patent attorneys, costs for translations of the application and adaptations to the national formal and legal requirements

the EPO or a foreign national office, or directly follow the PCT route. Thus in this section, we have only described the standard application procedure.

Advantages of PCT applications

Whereas the number of EPO applications increased considerably right from the beginning, the PCT procedure was only slowly accepted. However, since about 1987, the number of PCT applications has grown enormously and achieved a level of nearly 55,000 applications in 1997. Up to now, the increase of PCT applications seems not to be slowing down.

The growth of the PCT route has a considerable impact on the legal and administrative practices in the international patent system as well as on patent indicators, since the counting of patent applications in different national, regional, and international paths is complex. The easiest methodological solution is, of course, to wait for the final grants at the national level. However, there is often a considerable time lag between priority application and granting of patents, so that the decisive advantage of patents as early-warning indicators is lost. Therefore, we have to investigate how to deal with parallel application routes.

To understand the popularity of PCT applications, it is necessary to look at their major advantages. In the first years after 1978, the main reason for choosing the PCT route was the 'rescue' of a priority. Many firms decide only shortly before the end of the priority year to apply for foreign patents. However, it is difficult to translate an application and to adapt it to the legal requirements of the designated countries, so that direct national applications would require some time.

In contrast, a PCT application can be registered at the national patent office in the national language. For example, a French applicant can file the PCT document in French at the French Patent Office, although he/she aims at patent protection in the United States, Japan or South Korea. This advantage, however, proved not to be sufficient to attract a relevant number of applicants to the PCT procedure.

The decisive breakthrough came in 1984, when the Assembly of the PCT Union decided to extend Chapter II from 25 to 30 months. With the 25-month limit, the applicant did not have sufficient time to assess the outcome of the preliminary examination before the decision to enter the national or regional phase. The new ruling came into force in 1985, but achieved a significant impact only in 1987 when the United States accepted Chapter II. This decision marked the end of a period of concern as to the practicability and benefits of the PCT system.

The postponement of the entry of the national phase is a decisive advantage, as the transfer to national offices implies considerable cost, comprising official fees, payments to national patent attorneys, costs for translations of the application and adaptations to the national formal and legal requirements. In most cases, the priority year is too short for assessing whether an innovation will be successful on a specific foreign market. With the delay of two and a half years, it is much easier to decide whether the costs of a national patent application will be worthwhile or not.

Thus, the costs of a PCT application are considerable amounting to about US$13,500, including the international preliminary examination under Chapter II.[7] However, these costs are moderate compared to those of direct national applications in many countries. Against this background, the applicant saves a lot of money, if he/she comes, after 30 months, to the conclusion that several originally intended applications in foreign countries are not justified economically. Even if the decision is made to enter the national phase, he/she has to make the related expenses at the national offices much later, and therefore saves considerable capital costs.

A further advantage of the PCT procedure is the moderate cost of designating potential application countries, as the applicant pays increasing fees only up to eleven designated states. Every additional designation is free of charge, a ruling which leads to an inflationary designation of countries. In this way, the applicant keeps, for little or no additional money, every option for foreign applications open. So it may happen that, during the PCT process, a foreign market becomes interesting which the applicant had originally not taken into consideration, but which he has nevertheless designated as a precaution. The relevant language of the PCT procedure is that of the involved International Searching and Examining Authority. Therefore, until the end of the preliminary examination, the applicant and the relevant International Authority can generally communicate directly, which is again a considerable cost-reducing factor.

Another benefit from the perspective of applicants from some non-European countries[8] is the option to choose the EPO as the International Searching and Examining Authority. In this way, the applicant can assess his prospects to achieve patent protection in Europe in addition to his domestic protection. For example, a US applicant generally gets a first search report from the US Patent and Trademark Office (USPTO) within twelve months, so that the choice of the USPTO as International Searching Authority would not lead to additional information.

The outcome of the examination report by the EPO

can be different from that of the USPTO, because the legal requirements sometimes differ a little, but primarily because the EPO considers non-English search documents more systematically than the USPTO (Claus and Higham, 1982; Harvey, 1996). In consequence, the applicant gets an improved impression about the patentability of his invention.

In the early years, a major disadvantage of the PCT route was the very complex formal requirements of the application which sometimes led to a complete loss. Against this background, the Assembly of the PCT Union steadily streamlined the PCT procedure to improve the communication between the applicant, the WIPO and the International Searching Authority. As a major improvement, the applicant is given the opportunity to correct formal errors and does not run the risk of a total rejection because of formalities. Especially in 1992, the PCT regulations were extensively revised which made the use of the PCT system simpler and safer.

To sum up, the PCT procedure is advantageous, if patent protection in a larger number of European and non-European countries is sought. In particular, the possibility of a postponement of the cost-intensive decision of broad international patent protection proves to be a major advantage. In 1996, to give an example, Euro-PCT applications entering the regional phase represented about 36% of all applications at the EPO, and the interviewed experts assume that the PCT route will become the dominant path. Therefore it is necessary to examine in more detail how to deal with PCT applications in patent statistics, especially in the context of EPO applications.

Euro-PCT applications as patent indicators

The moderate costs of domestic patent applications and the high costs of foreign applications imply that only a limited share of the domestic priority applications is also protected in foreign countries. In consequence, the number of patent applications of residents at a national patent office is high in relation to applications of foreigners, when the patent numbers are compared to other R&D indicators such as R&D budgets or foreign trade data. The resulting structures are illustrated in Figure 1 where the situation at the German, US, Japanese and European patent offices are compared.

At the German Patent and Trademark Office (Deutsches Patent und Markenamt, DPMA), German applicants account for most of the patent applications because of their domestic advantage. If patents are taken as an indicator of technological competitiveness, Germany is obviously assessed too highly compared to the United States or Japan. However, the relation between the United States and Japan seems to be quite reasonable.[9]

At the USPTO, the structures are similar, but this time with a domestic advantage for US applicants and reasonable bilateral relations between Germany and Japan. At the Japanese Patent Office (Tokkyo Cho),

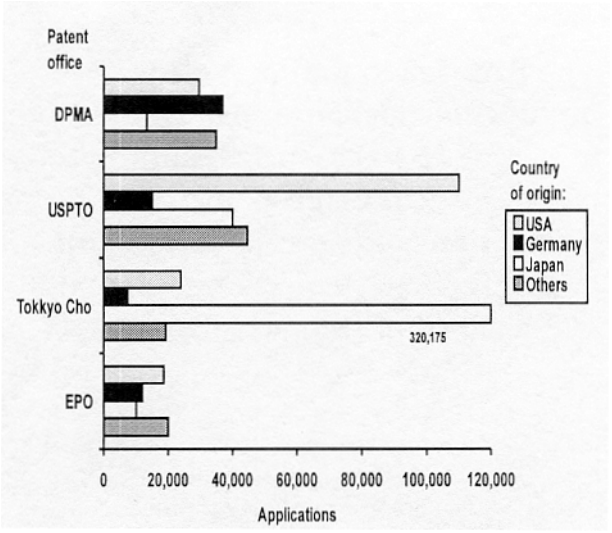

Figure 1. Patent applications at different patent offices for selected countries of origin, 1994

Source: WIPO (1996); database EPAT (Host Questel)

the domestic advantage of Japanese applicants is overwhelming, as Japanese applicants have an extremely high propensity to patent at their own office.[10]

As to the EPO, the relations between the countries considered are quite balanced, as, from the perspective of every country, EPO applications are foreign applications. In terms of technological strengths, the figures are, however, still not completely satisfactory, because European countries have a slight regional advantage, so that, for example, Germany has more EPO applications than Japan. Nevertheless, all in all, the framework at the EPO is quite clear and the impact of regional advantages can be assessed easily.

EPO figures have specific advantages, when relative indicators such as the specialisation indexes RTA or RPA[11] are derived (Schmoch, 1995; Soete and Wyatt, 1983). Specialisation indexes always refer to average distributions which determine their quality. In the case of national offices, the average distribution is largely dependent on the average distribution of the domestic country, especially in the cases of the USPTO and the Tokkyo Cho. In contrast, the average distribution at the EPO largely reflects an international average distribution, and therefore we see special advantages of using EPO data for patent statistics in international comparisons.

If we use European patent data for setting up patent indicators, we have to decide whether all PCT applications with destination EPO should be included or only those which are actually transferred to the EPO. The answer to this question has a significant statistical impact, since the relative weight of Euro-PCT within all European applications is high and still increasing, and the difference between all Euro-PCT applications and those actually transferred is considerable. Against this background, we asked our interview partners whether they assess direct European applications and PCT applications as equivalent or see different qualities.

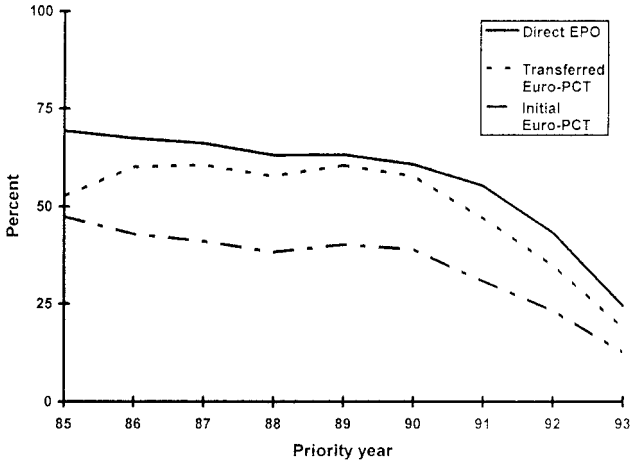

Figure 2. Comparison of grant rates of direct EPO, transferred Euro-PCT applications, and initial Euro-PCT designations for the priority period 1985–93 (%)

Sources: Databases PCTPAT and EPAT; Host Questel (update 29 January 1998)

Some of our interview partners, based on their practical experiences, supported the point of view that PCT applications are generally equivalent to direct EPO applications. However, others were less explicit, because they knew about research results that grant rates of direct EPO applications are higher than those of Euro-PCT applications. To check this in more detail, we analysed the grant shares of direct EPO applications, initial Euro-PCT designations and transferred Euro-PCT applications.[12] The result is illustrated in Figure 2 for the priority years 1985 through 1993.

The three curves generally decline in the observation period, since, in more recent years, the patent procedures are often not yet finished. For all priority years examined, the grant share of direct EPO applications is distinctly higher than that of the initial Euro-PCT designations, and it is even slightly higher than the grant rate of transferred Euro-PCT applications.

The increase of the grant share of transferred Euro-PCT applications between 1985 and 1986 must be interpreted against the background that, in this period, the attitudes of the applicants were in transition and the share of transferred PCT in 1985 was distinctly higher than in 1986. After 1986, the applicants were obviously more restrictive and only transferred the more promising applications. All in all, the differences of the grant shares are a strong indication that, in general, transferred Euro-PCT have a comparable quality to direct EPO applications.

Confronted with these figures, the supporters of an equivalence between direct European and initial Euro-PCT designations raised various points. Their most important argument is that the PCT procedure allows for a longer observation of the market potential of an invention, and, in case of a negative assessment, the application can be withdrawn before its entry into the expensive regional phase. However,

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this argument can be reversed in the way that inventions with unclear market potential are passed through the PCT route, whereas those with an unquestionable potential are directly applied at the EPO, since, in that case, the direct path is less expensive.

A further argument for the high rates of withdrawals during the international phase is, at least for some technologies, their short technology life cycle. If the next generation of products already enters the market at the end of the international phase, the entry of the regional phase would not be justified. Even in this situation, PCT application can have a deterrent effect on other competitors and therefore might be useful. This argument, however, also applies to direct EPO applications which, 30 months after the priority date, are generally still in an examination process and not yet granted. So these applicants could also withdraw their application before grant, if the life cycle of the invention is far advanced or the market potential proves not to be promising.

Since the owner of a PCT application has to pay for eleven destination countries at most, many applicants choose the option of a regional and national application in parallel. Therefore, the withdrawal of the PCT application might only refer to the European application and not to the parallel national application. This choice can be reasonable if, at the end of the international phase, the application proves to be economically justified in a few European countries only.

To check this argument, we analysed all PCT applications of the priority year 1990 with Germany as destination country, but with non-German applicants. Of this sample, we only considered those applications that were granted and achieved patent protection in Germany. Within this set, only 3.5% achieved the protection in Germany through the national PCT route. A further 1% was directly applied at the DPA in parallel with the PCT application. So the majority of 95.5% were derived from the grant at the EPO. All in all, the national PCT path plays a minor role and has no significant impact on the withdrawal rate of Euro-PCT applications.

Considering all these points, the relatively high withdrawal rates in the regional phase of Euro-PCT applications, that is, after the preliminary examination, still needs further clarification. A first reason is the fact that about 60% of the US applicants and 94%

of the Japanese applicants do not choose the EPO as International Searching Authority. The USPTO and the Tokkyo Cho base their examinations primarily on English- and Japanese-language documents respectively, whereas the EPO covers a broader set of documents. Therefore the EPO examination can bring up new documents leading to a withdrawal of an application.

In addition, the time of grant of Euro-PCT applications is delayed with reference to direct EPO applications, and the period for observing the market potential is longer. We assume that this delay is the major reason for the slight difference between transferred Euro-PCT and direct EPO applications.

As the counter arguments discussed above are only partly convincing, we see considerable evidence for the hypothesis that a PCT application is primarily chosen for inventions for which the market potential is less clear. Therefore the lengthened decision period for broad international protection is taken as a test period for the market potential, and PCT applications have a largely experimental character, whereas direct EPO applications are made with the definite target of achieving broad European patent protection from the very beginning.

As to the statements of the experts interviewed, we assume that they assess the technological quality of the inventions primarily and take their economic value less into account. The PCT process, however, is mainly an opportunity for assessing the economic potential and selecting economically promising ideas. If we are to consider patent indicators chiefly as economic indicators, the above findings suggest including only transferred Euro-PCT applications in EPO-based statistics.

If only transferred Euro-PCT applications are included in EPO statistic, this has a considerable impact on the accessibility of the data. In the case of the EPO, the transfer into the regional phase must take place 31 months after the priority date. Then the EPO must give the applicant the opportunity to correct an omission of the transfer. Furthermore, the preparation of the document for an EPO publication takes a certain time, so that the delay between the priority date and the EPO publication can be up to 35 months.

To verify this expert statement, we analysed the publication sequence for Euro-PCT applications at the EPO for the priority months January 1988 and January 1993. In Figure 3, the result of this analysis is documented: the abscissa values represent the time after the priority application. For example, February 1988 is the first month with reference to January 1988, and January 1989 the 12th month. Both curves show a first publication peak at about the 24th month which refers to Euro-PCT applications transferred at the end of Chapter I. The second peak is in the 34th month, and only very few applications are published later.

Taking into account that there is a further delay between the official publication and the entry in the on-line database of about two weeks, the almost

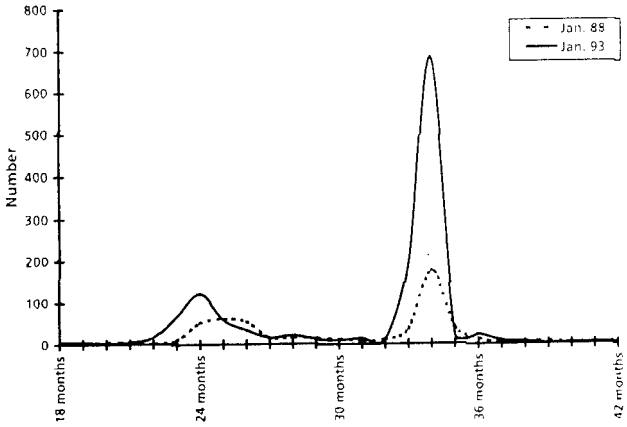

Figure 3. Delay of publication of transferred Euro-PCT applications of priority months January 1988 and January 1993 with reference to priority date
(month-by-month basis)

Source: Database EPAT, Host Questel (update 27 January 1998)

complete number of publications is available in the 35th month after the priority date. Thus in December 1997, we had the almost complete number of transferred Euro-PCT applications for the priority year 1994. In contrast, the direct EPO applications of 1994 were already available in August 1996. So, because of the Euro-PCT procedure, we lose the advantage of the early publication of EPO documents, and we have to think about appropriate methods of projecting transferred Euro-PCT applications. In the next section, we will investigate the structures of the Euro-PCT system in more detail to identify appropriate starting points for such a projection.

Figure 3 also illustrates that the absolute number of Euro-PCT applications between 1988 and 1993 increased considerably as well as the relative weight of the choice of Chapter II. As to 1988, 37% of the transferred Euro-PCT applications were transmitted after Chapter I, whereas regarding January 1993, this share was only 21%. We assume that these trends towards an increasing use of the Euro-PCT route and of Chapter II will continue, so that the necessity for appropriate projection methods will become even more urgent.

Structures of Euro-PCT system

Use of Euro-PCT applications by different countries

For assessing the structure of the PCT system, it is helpful first to take a look at the overall situation as documented in Table 1.[13] This shows the steady growth of the PCT applications since the priority year 1985, and also of those applications transferred to the EPO. In parallel with the increase of the PCT route, the direct applications at the EPO have decreased since 1989. The transferred Euro-PCT applications declined in 1995 because, at the time of the search, only the documents which entered the regional phase

Table 1. Total number of EPO and Euro-PCT applications for priority years 1985 to 1995

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Effective EPO applications	42,932	45,367	51,627	57,281	61,609	60,794	59,153	58,584	59,582	61,209	45,543
Direct EPO applications	36,263	39,244	43,979	48,182	49,742	46,549	43,803	40,617	38,591	36,703	36,188
Transferred Euro-PCT applications	6,669	6,123	7,648	9,099	11,867	14,245	15,350	17,967	20,991	24,506	9,355
Initial Euro-PCT designations	7,420	8,574	11,294	13,730	17,874	21,096	23,417	27,051	31,529	36,555	44,099
Potential EPO applications	43,683	47,818	55,273	61,912	67,616	67,645	67,220	67,668	70,120	73,258	80,287
Transferred Euro-PCT to effective EPO	16%	13%	15%	16%	19%	23%	26%	31%	35%	40%	21%
Transferred to initial Euro-PCT applications	90%	71%	68%	66%	66%	68%	66%	66%	67%	67%	21%
Potential to effective EPO applications	102%	105%	107%	108%	110%	111%	114%	116%	118%	120%	176%

Source: Databases PCTPAT and EPAT, Host Questel (update 13 January 1998)

after Chapter I appear in the database. In Table 1, we show not all PCT applications, but only those with the EPO as designation office.[14]

If we compare the number of effective EPO applications, that is, direct EPO plus transferred Euro-PCT applications, with the number of potential EPO applications, that is, direct EPO applications plus initial Euro-PCT designations, the levels are almost the same at the beginning of the observation period and considerably diverge in more recent years (see last row in Table 1). Whereas the relation of potential to effective EPO application was 102% in 1985, it was 120% in 1994. This illustrates again that it is important whether the effective or the potential EPO applications are taken as the basis for patent indicators.

The intensified use of the PCT system also becomes obvious when the share of transferred Euro-PCT within the effective EPO applications is considered: this increases between 1985 and 1994 from 16 to 40%. With the major exception of 1985, which can be considered to be a transition phase, the transfer rate of Euro-PCT applications to the EPO has remained quite stable and currently has a level of about 67%.

These general figures do not represent the relations for single countries, as the country patterns are very heterogeneous. If we look, for example, at the share of transferred Euro-PCT within the effective EPO applications in 1994, they cover a range from 19% for Japan up to 91% for New Zealand. Furthermore, these patterns change in the course of the observation period. To gain an impression of the underlying structures, we document in Figure 4, for the two structural relations of potential to effective EPO applications and of transferred Euro-PCT within effective EPO applications, whether the 29 OECD countries considered have shares equivalent to the overall average or shares above or below average.

As to the relation of transferred Euro-PCT within the effective EPO applications, we see a concentration of smaller countries on shares above average. This can be taken as an indication that the Euro-PCT route is more attractive for smaller countries. However, Great Britain and the United States also have Euro-PCT shares above average, so that it is not possible to derive general patterns for smaller versus larger countries. Germany, France, Italy and Japan have Euro-PCT shares below average and prefer the direct EPO route, which also applies to Switzerland, Iceland and South Korea.

As to the transfer rates of Euro-PCT applications, many countries are near the average level. There is, however, still a broad variety of transfer shares not only between countries, but also, at least for small countries, between reference years (see Table 2). As a result of this heterogeneous structure, the relations

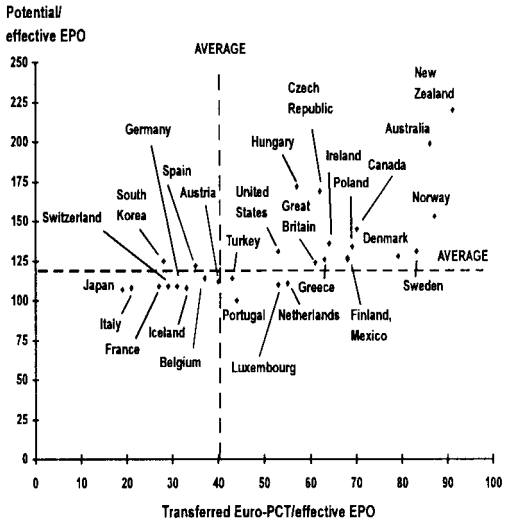

Figure 4. Relations of potential to effective EPO applications and of transferred Euro-PCT to effective EPO applications for 27 OECD countries in 1994 (%)

Table 2. Relation of transferred to initial Euro-PCT applications (%)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Australia	87	61	47	45	44	50	51	48	49	47	10
Austria	98	85	69	78	76	79	81	77	78	77	33
Belgium	89	64	65	66	70	68	73	71	73	73	22
Canada	98	80	69	61	62	55	58	60	57	61	14
Czech Republic	-	-	-	100	-	57	53	50	56	47	12
Denmark	96	61	56	63	75	68	72	72	73	74	16
Finland	83	69	70	63	63	59	64	64	63	72	19
France	84	63	56	55	63	68	68	73	75	74	28
Germany	90	74	71	73	79	78	76	79	79	78	24
Great Britain	90	66	62	59	64	68	68	70	69	72	17
Greece	100	60	0	67	91	56	55	48	55	71	34
Hungary	87	75	59	64	63	48	56	41	40	44	8
Iceland	100	0	100	67	100	100	83	33	100	80	0
Ireland	100	60	69	69	63	88	65	63	66	64	63
Italy	95	73	64	68	73	68	69	69	69	73	68
Japan	70	74	77	80	80	80	77	72	72	74	39
Luxembourg	100	100	100	100	67	100	75	83	47	84	14
Mexico	-	75	100	40	44	75	67	75	87	71	12
Netherlands	87	64	57	64	73	74	67	78	78	84	46
New Zealand	50	100	63	78	50	57	51	42	35	43	5
Norway	98	60	59	64	63	61	63	66	65	62	17
Poland	100	100	50	33	50	35	59	29	47	67	6
Portugal	100	-	100	50	100	100	80	50	67	100	17
South Korea	68	65	46	53	47	39	54	46	48	53	28
Spain	94	89	52	69	78	61	59	65	57	62	42
Sweden	88	69	70	67	69	68	70	75	74	72	15
Switzerland	91	72	66	73	76	78	84	83	81	77	28
Turkey	-	-	-	100	-	100	100	-	86	75	10
USA	98	74	70	66	64	66	62	63	63	63	17
Total	90	71	68	66	66	68	66	66	67	67	21

Source: Database EPAT, Host Questel (update 13 January 1998); own calculations

between potential and effective EPO applications are heterogeneous as well. Including the initial PCT designations in patent statistics would favour countries such as Australia, New Zealand, Norway, Sweden, or the United States and handicap, for example, Switzerland, Germany, France, Italy, Japan, or the Netherlands. If the analysis is restricted to larger countries, the structures are more homogeneous, but the transfer shares still vary by 22%,[15] and the relation of potential to effective EPO applications by 24%,[16] in 1994.

All these considerations show that it is not possible to detect systematic patterns of the use of the PCT system, for example, according to the country size or to European versus non-European countries. In consequence, projections for the effective EPO applications, including transferred Euro-PCT applications, have to be made on a country-by-country basis.

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PCT structures at national patent offices

Previously, we analysed the PCT structures at the EPO, because this patent office proves to be appropriate for establishing patent indicators for international comparisons. For other purposes, however, it can be useful to analyse the situation at specific national offices as well. For example, the US market is very interesting for leading-edge technologies and is more attractive for East Asian countries than the European market. Japan is a key market for East Asia, and applications at the Tokkyo Cho can show the technology flows into this region. Finally, the German market is a key one for Europe, and reflects a broader spectrum of applications than the EPO. Therefore, we chose these three national offices for further analyses of the impact of PCT applications.

Starting with the German DPMA we investigated the application structure for the four largest foreign countries — France, Great Britain, Japan and the United States. According to usual standards for patent indicators, the determination of the country of origin was made by the inventor country. The effective applications at the DPMA, including direct EPO and transferred Euro-PCT applications, are only slightly higher than the effective EPO applications in recent years. However, in the first years of the observation period, the share of direct applications at the DPMA was much higher, and we can observe a steady shift from the national to the EPO route. All in all, the PCT structures at the DPMA and EPO are almost equivalent.

The statistics at the US Patent and Trademark Office (USPTO) cannot be directly compared to those at the DPMA, as the USPTO does not publish applications, but only granted patents. It can be assumed that the number of the granted patents is about 30 to 40% lower than that of the original applications, and, because of the delay by the examination procedure, US patents are generally published later than EPO applications.

In Table 3, this effect becomes visible in a decline of the total number of granted patents since about the priority year 1991. Thus the publication delay as a result of the grant process at the USPTO is higher than the delay induced by the increased use of Chapter II of PCT applications. However, the delayed transfer of PCT applications into the national phase has an indirect impact on the USPTO statistics, because the grant procedures at the USPTO for PCT applications start later than for direct applications.

The relative share of transferred (granted) PCT patents within all patents at the USPTO is generally lower than at the EPO. However, these figures should be directly compared only until about 1991 because of the distortion by the late USPTO publications. The most remarkable point is the very low PCT rate of Japanese applicants at the USPTO who obviously prefer direct applications at this national office.

As to the USPTO, the impact of PCT applications is less important than at the DPMA or EPO, because many applicants prefer the direct national route. However, the impact is not negligible and leads to a delayed start of the examining procedure. As the USPTO will introduce a strict publication period of 18 months after the priority date, together with an acceleration of the examination, this might imply a mixed structure of the published documents with granted patents in the case of direct applications, on the one hand, and applications in the case of PCT documents, on the other hand.[17] In any case, there will be a transition period between the old and the new publication regimes.

In the case of the Japanese Patent Office (Tokkyo Cho), the country of origin had to be determined on the basis of the priority country and not, as in all other cases, by the inventor country, as the inventor country is not available in the database EPIDOS/INPADOC.[18] However, this different definition has only a minor impact, as cross-checks with the database JAPIO showed. Like national European offices and the EPO, the Tokkyo Cho publishes patent applications 18 months after the priority date. Nevertheless, the overall figures already decreased in 1994 because of a

Table 3. PCT structures at US Patent and Trademark Office for selected OECD countries

	Origin	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Effective granted patents	Germany	7,062	7,217	7,774	7,772	7,691	6,931	6,898	6,629	5,943	4,198	1,361
	France	2,549	2,657	2,905	3,037	3,123	3,047	2,889	2,749	2,418	1,610	443
	Great Britain	2,514	2,682	2,715	2,770	2,605	2,366	2,268	2,063	1,562	892	299
	Japan	15,659	16,918	20,025	21,620	22,467	22,831	21,368	20,307	18,918	12,571	4,264
Transferred granted PCT application	Germany	405	454	607	721	908	948	1,090	1,177	875	160	8
	France	180	203	215	246	311	381	431	443	326	89	8
	Great Britain	289	299	380	465	546	682	765	739	411	66	4
	Japan	370	570	708	713	796	882	810	900	772	267	18
Initial PCT designations	Germany	922	1,004	1,408	1,849	2,421	2,546	2,808	3,327	3,861	4,706	5,819
	France	435	486	614	686	905	1,073	1,261	1,330	1,569	1,769	2,127
	Great Britain	679	809	1,026	1,353	1,845	2,230	2,256	2,501	2,742	2,955	3,184
	Japan	684	948	1,298	1,238	1,603	1,778	1,676	1,843	2,271	2,516	3,697
Transferred PCT to effective granted patents	Germany	6%	6%	8%	9%	12%	14%	16%	18%	15%	4%	1%
	France	7%	8%	7%	8%	10%	13%	15%	16%	13%	6%	2%
	Great Britain	11%	11%	14%	17%	21%	29%	34%	36%	26%	7%	1%
	Japan	2%	3%	4%	3%	4%	4%	4%	4%	4%	2%	0%

Sources: Databases IFIPAT, Host STN, and PCTPAT, Host Questel (update 30 January 1998)

Table 4. Error rate of projections for effective EPO applications of priority year 1994 from perspective of a fictitious database search in December 1996

	1) Linear trend – 1 year	2) Linear trend – 3 years	3) Exceptional trend	4) Trend potential EPO	5) Transfer rated – 1 year	6) Transfer rated – 3 years
Australia	4.3	2.5	2.2	4.3	3.6	4.7
Austria	3.3	4.7	4.7	0.0	5.1	5.9
Belgium	17.4	12.9	16.9	2.3	0.0	0.2
Canada	0.5	1.3	0.7	2.3	3.8	2.4
Czech Republic	27.6	8.6	9.2	11.3	11.6	7.5
Denmark	0.6	0.2	1.6	1.4	0.7	1.2
Finland	7.8	6.7	4.8	6.9	8.6	8.0
France	0.9	5.9	5.9	0.9	0.2	0.8
Germany	4.5	5.5	5.5	1.5	0.5	0.1
Great Britain	2.3	3.9	3.9	0.4	1.9	2.1
Greece	113.2	36.8	43.7	18.8	14.4	16.1
Hungary	1.9	15.7	11.8	7.7	5.3	1.9
Iceland	0.0	50.0	47.0	8.3	8.3	3.2
Ireland	42.9	15.8	16.5	4.6	1.5	0.2
Italy	0.7	4.8	4.8	0.1	1.0	1.0
Japan	3.7	8.3	6.6	0.4	0.6	0.1
Luxembourg	83.3	1.7	2.6	7.6	23.8	10.1
Mexico	59.1	6.8	3.7	17.8	14.5	4.5
Netherlands	0.0	3.7	3.7	1.7	3.9	6.1
New Zealand	18.9	14.9	39.9	13.5	16.1	0.2
Norway	14.7	13.9	17.1	6.9	3.1	2.7
Poland	0.0	22.4	22.5	23.6	20.1	22.2
Portugal	93.8	46.9	56.8	21.4	14.6	15.1
South Korea	10.5	6.8	4.9	1.5	6.1	8.9
Spain	11.1	1.5	0.1	3.4	2.8	0.9
Sweden	9.9	9.6	9.0	3.6	1.5	0.4
Switzerland	6.5	1.5	1.5	2.6	1.5	2.2
Turkey	185.7	21.4	16.0	4.8	6.1	11.6
USA	2.5	3.8	3.8	2.3	0.2	0.3
Total	1.0	4.5	4.4	1.7	0.3	0.5
Average	7.6	3.0	2.1	0.9	2.3	1.9
Standard deviation	48.7	17.0	19.5	9.1	8.6	6.8

delayed report by the Tokkyo Cho to EPIDOS/INPADOC.

As in the case of the DPMA, the share of transferred PCT applications has steadily increased at the Tokkyo Cho and reached a level comparable to that of the DPMA. France, Germany and Great Britain have lower transfer shares at the Tokkyo Cho than at the DPMA or EPO. This can be taken as an indication that, from the European perspective, the market situation in Japan is often unclear, and a PCT application has to be considered as a careful option. All in all, the impact of the PCT route on foreign applications at the Tokkyo Cho has become important. Therefore a database such as JAPIO, including only direct applications at the Tokkyo Cho, gives an incomplete picture and should only be used for Japanese applicants.

To summarise, the impact of the PCT system on national patent offices is less important than on the EPO, but is still far from negligible.

Projection of effective EPO applications

When discussing Euro-PCT applications as patent indicators, considerable evidence was found that only the transferred Euro-PCT and not the initial Euro-PCT applications can be thought of as equivalent to direct EPO applications. Therefore it is necessary to look for appropriate projection methods for the effective EPO applications, that is, direct EPO plus transferred Euro-PCT applications.

For that purpose, we tested the situation for the priority year 1994 from the perspective of a database search in December 1996. At that time, the direct EPO and the initial Euro-PCT applications, and thus the potential Euro-PCT applications, were available until 1994, whereas the number of transferred Euro-PCT applications were only complete until 1993. We tested the following projection methods for 1994:

1) Linear trend projection of the effective EPO applications on the basis of the years 1992 and 1993 without considering the initial Euro-PCT applications of 1994.
2) Linear trend projection of the effective EPO applications based on a linear regression through the years 1990 to 1993.
3) Exponential trend projection of the effective EPO applications based on the years 1990 to 1993.
4) Trend projection of the effective EPO applications, assuming the proportion between 1993 and 1994 to be the same as the proportion of the potential EPO applications between 1993 and 1994.
5) Trend projection of effective EPO applications based on the direct EPO applications plus the initial Euro-PCT designations of the year 1994, with the Euro-PCT designations multiplied by the transfer rate of the year 1993.
6) Trend projection equivalent to approach 5, but with the average transfer rate of the years 1991 to 1993.

We can assume that the last three approaches lead to the best fit, because they are based on the real development of the potential Euro-PCT applications of 1994 and only assume, explicitly or implicitly, an equivalent transfer rate to former observation periods.

In Table 4, we document the error rate for the different projection methods and the 29 OECD countries analysed. Except for the linear trend projection based on one year (approach 1), all projection methods have low average error rates in the range of –3.0 to –0.9%. However the standard deviation rates are only acceptable for the three last projection methods, in agreement with our hypothesis. A good approach is obviously number 4), on the basis of the trend of the potential Euro-PCT applications, with the approaches 5) and 6) being nearly equivalent. This impression is confirmed by a check for the 18 largest countries with more than 80 potential EPO applications in 1994, where the average error rate for the fourth approach is 1.1% and the standard deviation 2.9%.[19]

All in all, the projection quality is very good for all larger countries and still acceptable for most smaller countries. The major unsatisfactory cases are Poland and Portugal, which have a low absolute level of EPO applications with less than 30 in 1994 and considerable annual fluctuations. Even in these two cases, the error rate is less than 25%.

As an alternative, we could make use of a combination of approaches 4) to 6), weighted by one third each, which implies a further improvement of the forecast quality.[20] However, we would be cau-tious about suggesting this approach as standard, because it implies more error sources in the practical work.

These projection methods can also be used for country comparisons in specific technology areas as long as the related samples are not too small, that is, not below a level of about 30 effective EPO applications per country per year. In summary, the projection methods we have suggested here seem to be a valid basis for establishing up-to-date indicators at the EPO.

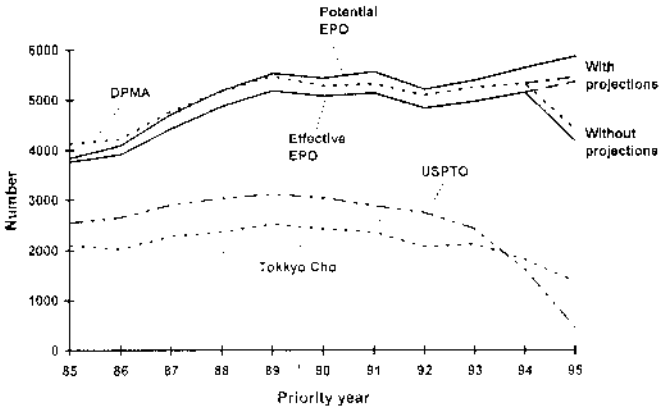

Figure 5. Patent applications with French origin at the DPMA, EPO, USPTO and Tokkyo Cho

Sources: Databases PATDPA, EPAT, PCTPAP, IFIPAT, EPDOS/INPADOC; hosts Questel and STN (update, January 1998)

French patent applications

To illustrate the consequences of the considerations of this paper, we document, as an example, the patent applications of France at different patent offices (see Figure 5). Although France belongs to the group of countries with moderate differences between effective and potential EPO applications, the difference between the two curves is clearly visible. Especially in recent years, most of the foreign applications in Europe are made through the EPO, so that the difference between effective EPO and DPMA applications becomes negligible. As a result of the projection for 1995, we achieve reliable recent data for French patent activities.

In contrast, the trend at the USPTO seems to be realistic only until 1990 because of the delay of the grant process. The granted patents for the priority year 1991 are largely complete, but there is no realistic basis for an estimate of the grants that are still missing, so that the increase at the EPO in 1991 is not visible in the USPTO data.

As to the Tokkyo Cho, the delayed report of the application data to the database EPIDOS/INPADOC only allows for realistic data until the priority year 1993. Therefore, the analysis at the EPO or other national offices in Europe provides the most recent results, in particular if a projection of the effective applications on the basis of the initial PCT applications is made.

Conclusions

In recent years, the use of patent indicators for analysing innovation processes has made substantial progress. However, many scholars are not aware of the influence of international applications according to the so-called PCT scheme. The number of PCT applications has increased enormously, because of their various advantages for the applicants, the most important being the possibility of delaying the decision on foreign applications by one and a half years. The applicant firm has more time to achieve an improved assessment of the market relevance of its invention and can avoid considerable costs.

The qualitative and quantitative analyses of this article show a substantial impact of PCT applications on statistics at national and regional patent offices and a significant difference between initial designations in the international phase and applications actually transferred to the national or regional phase.

According to an evaluation of grant rates at the European Patent Office, only transferred PCT applications prove to be as successful as direct filings. This has consequences for the topicality of patent statistics, because the initial PCT applications are published one and a half years after the first registration of the invention, like European or Japanese applications, but their transfer to a national or regional office is made public almost three years after the priority date. It is, however, possible to provide reliable projections based on recent trends of initial PCT applications, so that European patent applications keep their advantages as early-warning indicators.

Patent statistics from the US American market are of special interest, because this market is very attractive for technology-intensive inventions and for applicants from North and South America as well as East Asia. At the USPTO, the impact of PCT applications is less important than at the EPO, but it is still significant. The PCT procedure delays the entrance of foreign applications into the national US system and the start of the examination process, and linked to that the publication of granted patents. Therefore, the available publications of granted patents generally reflect quite old data.

In the case of the USPTO, it does not seem to be possible to develop reliable projection methods exclusively based on USPTO and PCT data. A potential solution, not examined in this paper, might be a projection based on European trends, because trends at the EPO and the USPTO are often quite similar.

In any case, the production of patent indicators has to take PCT applications explicitly into account, no matter at what specific office the statistics are carried out. The PCT system has induced considerable dynamics into all patent systems of the world and it cannot be foreseen when and whether a new stable situation will be reached. However, the analyses of this paper show that it is possible to cope with this situation and that the quality of European patents as early-warning indicators can be preserved.

Notes

1. In technometric indexes, technical features of products are compared (see Grupp, 1994; 1998, chapter 3).
2. The most important sources used are documented in the reference list.
3. These are Mr G Kolle, Director of International Affairs at the European Patent Office, Munich, Mr B Bartels, Director of the PCT Sector at the World Intellectual Property Organisation, Geneva, Mr E Wolff, Senior Legal Officer at the PCT Legal Division of the World Intellectual Property Organisation, and, to include the perspective of patent applicants, the patent attorney Dr Keller, responsible for PCT applications in the patent attorney's office Lederer, Keller and Rieder, Munich.
4. The first registration is always called priority application whatever the effective office of first application is.
5. Status: February 1998.
6. At the EPO, this delay is 31 months.
7. These costs include official fees and primarily the costs of the patent attorney. The estimates are based on Armstrong and Associates (1997) and apply to American assignees. The official fees are much lower: about US$3,200 if the USPTO is chosen as International Searching and Examining Authority, US$5,300 if the EPO is chosen. These fees comprise all official costs, as, in contrast to national or regional offices, the WIPO does not charge annual fees.
8. Primarily applicants from the United States and Japanese applicants with PCT applications in English.
9. Since the largest part of American and Japanese applications for Germany are filed through the EPO, the figures take into account both direct applications at the DPA and indirect applications through the EPO.
10. The Japanese bar is cut at a level of one third.
11. RTA is revealed technological advantage, RPA is revealed patent advantage. RTA measures the patent share of a country in a specific technological field in relation to the average share of this field for all countries. RPA mathematically transforms RTA for an improved symmetric representation.
12. We define 'initial Euro-PCT designations' as those PCT applications that have the EPO as original designation regardless of whether they are really transferred to the EPO.
13. The detailed figures for 29 OECD countries at the EPO are documented in Schmoch (1998).
14. In the database, it is, however, not possible to identify explicitly designation offices, but only designation countries, so that we had to introduce a general correction factor. According to official statistics, the share of applications with the EPO as designation office within all PCT applications is 96%. This general correction might lead to slight inconsistencies for countries with few patent applications.
15. Maximum: 84% (Netherlands); minimum: 62% (Spain).
16. Maximum: 131% (United States); minimum: 107% (Japan).
17. According to the new *Patent Publication Act*, patent applications at the USPTO will be published 18 months after the priority date, except for those that will not be the subject of an application filed in a foreign country.
18. In this database, the inventor country is available for other patent offices, for example, the USPTO, but not for the Tokkyo Cho.
19. For the 18 largest countries, the following averages and standard deviations were calculated for the six approaches: 1) 0.1, 7.6; (2) –2.4, 6.1; (3) –0,9, 7.1; (4) 1.1, 2.9; (5) –1.3, 3.1; (6) –1.6, 3.5.
20. This method is explained in more detail in Jungmittag (1998). By this method, an average value of –1.7 and a standard deviation of 7.7 is computed, and in 20 of the 28 cases slight improvements are achieved compared to the fourth approach.

References

J Anglehart (1995), "Extending the international phase of PCT applications", *European Intellectual Property Review*, 17(2), pages 81–86.

Armstrong and Associates (1997), "Patent Cooperation Treaty (PCT) Applications", Homepage: http://www.canpat.com/pctinfo.htlm (update: 10 October).

J Beier (1995), "Die tatsächlichen Patentkosten im europäischen und nationalen Verfahren", *GRUR International 2*, pages 113–120.

B W Brown (1997), "Patent Cooperation Treaty (PCT). National stage commencement and entry in the United States of America", *Journal of the Patent and Trademark Office Society*, 79(4), pages 296–304.

P Claus and P A Higham (1982), "Study of citations given in search reports of international patent applications published under the Patent Cooperation Treaty", *World Patent Information*, 4(3), pages 105–109.

X Debontride (1993), "Le brevet, une arme stratégique à découvrir", *L'Usine Nouvelle*, 2414, 10 June, pages 36–39.

DPA, Deutsches Patentamt (editor) (1996), *Taschenbuch des Gewerblichen Rechtsschutzes, 3rd and 4th volume, Internationaler Teil* (Carl Heymanns Verlag, Köln, München).

EPO, European Patent Office (editor) (1991), *European Patent Convention* (Wila Verlag, München).

F B Fischer (1986), *Grundzüge des Gewerblichen Rechtsschutzes* (Carl Heymanns Verlag, Köln, Berlin, Bonn, München).

G Gall (1997), *Die europäische Patentanmeldung und der PCT in Frage und Antwort* (Carl Heymanns Verlag, Köln, Berlin, Bonn, München, 4th edition).

H Grupp (1994), "The measurement of technical performance of innovations by technometrics and its impact on established technology indicators", *Research Policy*, 23, pages 175–193.

H Grupp (1998), *Foundations of the Economics of Innovation — Theory, Measurement and Practice* (Edward Elgar, Cheltenham).

D Guellec and B van Pottelsberghe (1998), "New indicators from patent data", contribution to the joint NESTI/TIP/GSS workshop, 17 June in Paris.

U C Hallmann (editor) (1981), *PCT, Vertrag über die internationale Zusammenarbeit auf dem Gebiet des Patentwesens* (Carl Heymanns Verlag, Köln, Berlin, Bonn, München, 2nd edition).

M Harvey (1996), "Patent office citations", *EPIDOS News*, 3/96, page 7.

A Jungmittag (1998), "Combination of forecasts", in S Kotz (editor) (1998), *Encyclopedia of Statistical Sciences*, update Volume 2 (Wiley-Interscience Publication, New York) pages 258–263.

G L Knight (1997), "It's time to stop discrimination against PCT/USA national phase patents", *Journal of the Patent and Trademark Office Society*, 79(6), pages 385–400.

OECD, Organisation for Economic Co-operation and Development (editor) (1994), *Using Patent Data as Science and Technology Indicators*, *Patent Manual 1994. The Measurement of Scientific and Technological Activities* (OECD, Paris).

S Scheer (1994), "Internationales Patent-, Muster- und Warenzeichen-Recht" (H Scheer Verlag, Hürth/Köln).

U Schmoch (1990), *Wettbewerbsvorsprung durch Patentinformation, Handbuch für die Recherchenpraxis* (Verlag TÜV Rheinland, Köln).

U Schmoch (1995), "Evaluation of technology strategies of companies by means of MDS maps", *International Journal of Technology Management*, 10(4/5/6), pages 426–440.

U Schmoch (1998), "Impact of international patent applications on patent indicators", contribution to the joint NESTI/TIP/GSS workshop, 17 June in Paris.

L G Soete and S M E Wyatt (1983), "The use of foreign patenting as an internationally comparable science and technology output indicator", *Scientometrics*, 5, pages 31–54.

WIPO, World Intellectual Property Organisation (1986ff), *PCT Applicant's Guide/Patent Cooperation Treaty* (WIPO, Geneva, in loose-leaf form).

WIPO, World Intellectual Property Organisation (1991), "Streamlined procedures under the Patent Cooperation Treaty (PCT)", *Journal of the Patent and Trademark Office Society*, 73(10), pages 799–802.

WIPO, World Intellectual Property Organisation (1996), *Industrial Property Statistics 1994, Part I: Patents, Utility Models* (WIPO, Geneva).

WIPO, World Intellectual Property Organisation (several years), "Patent Cooperation Treaty (PCT) News", *Journal of the Patent and Trademark Office Society*.

WIPO, World Intellectual Property Organisation (several years), "The Patent Cooperation Treaty (PCT)", *Journal of the Patent and Trademark Office Society*.

WIPO, World Intellectual Property Organisation (several years), WIPO Press Releases PCT (WIPO, Geneva).