

The European Patent System: A Descriptive Analysis

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Abstract

The European Patent System consists of national patent offices (NPOs) and the supranational European Patent Office (EPO). EPO and the NPOs have granted patents in Europe side-by-side since 1980. The resulting patent system is complicated and less coordinated than might be expected. Firms must consider a number of variables when selecting the route of patenting they take within this system: price, rigour of examination, duration of examination, quality of legal redress. To date there is little descriptive evidence on how firms choose between EPO and national offices. This paper provides a rich descriptive analysis of patenting in Europe. We analyze how origin, size and technological focus of companies, affect how they choose among patent offices within the EPS and report differences in examination durations and grant rates across patent offices.

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Author Note

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Abstract

The European Patent System consists of national patent offices (NPOs) and the supranational European Patent Office (EPO). EPO and the NPOs have granted patents in Europe side-by-side since 1980. The resulting patent system is complicated and less coordinated than might be expected. Firms must consider a number of variables when selecting the route of patenting they take within this system: price, rigour of examination, duration of examination, quality of legal redress. To date there is little descriptive evidence on how firms choose between EPO and national offices. This paper provides a rich descriptive analysis of patenting in Europe. We analyze how origin, size and technological focus of companies, affect how they choose among patent offices within the EPS and report differences in examination durations and grant rates across patent offices.

Keywords: Patents, European Patent System, Validation

The European Patent System: A Descriptive Analysis

The European Patent System (EPS) has consisted of National Offices (NPOs) and the European Patent Office (EPO) since 1978.¹ The administrative rules governing the EPS have changed numerous times, be it because of administrative changes (e.g. adjustments to fee schedules and patent office rules), legal changes (e.g. patentability of genes) or due to judicial decisions (e.g. on parallel imports). The current paper makes no attempt to survey the history of these changes, some of which are reviewed by Plomer (2015). Its purpose is to document how the EPS has been and is being used by companies that patent inventions.

There is a literature which analyses aspects of how the EPS functions and that we do not review in detail here. This literature is surprisingly small. Hall & Helmers (2018) analyse accession of a series of countries to the EPS. Mejer & Van Pottelsberghe (2012) study the functioning of the EPS at an aggregate level and document the complexity of the current system, the genesis of which is laid out by Plomer (2015). Validation of patents within the EPS is analysed by Harhoff, Hoisl, Reichl, & Van Pottelsberghe (2009) and in Harhoff, Hoisl, Vandeput, & Van Pottelsberghe (2016). These papers do not provide the detailed description of how the EPS is used that we provide here.

A much larger literature uses data from the EPO to analyse various aspects of companies' patenting behaviour in Europe. Some of this work is surveyed by Harhoff &

Hall (2012). This literature has not so far used data from NPOs in Europe.

This paper is descriptive: it outlines how companies use the patent system, not why they make the choices we document. Such a descriptive analysis may be useful for those embarking on analytical projects, which seek to uncover causal effects of administrative, legal or judicial reforms. It may also be helpful as a record of how the EPS worked prior to the significant legal and administrative changes that will be brought about when the Unitary Patent and the Unified Patent Court begin to operate in the near future. We note that while our descriptive analysis is intended to present facts about the use of patents in Europe, none of the graphs presented below can be read as showing that there are causal relationships between the variables we describe. In analyses of patent data policy makers are often interested to understand whether stronger or broader protection has effects on job creation, productivity or economic growth.² This paper does not engage directly with these questions and does not adopt forms of analysis that are suited to uncovering causal effects. We do provide some comparative analysis of patenting that raises questions about future potential for growth based on innovation in some European countries. An answer to these questions will require a different approach from that adopted here.

The main aim of our paper is to set out facts about the EPS which are presented in the form of graphs and tables. To structure

¹ van Pottelsberghe (2014) defines the EPS as “the policy mechanisms, jurisdictions, and institutions in Europe which allow inventors to acquire and enforce industrial property rights over their inventions.”

² Two recent reports that have provided some insight into the correlations between use of IP and jobs in Europe and are published by [EU IPO](#) (Webpage last accessed on the 18.8.2018).

the analysis, we set out questions about the EPS. These are broadly motivated by the desire to understand how companies use the EPS to protect patentable inventions.

The paper is structured as follows: first we set out the motivating questions, then we present results and discussion of these. Following this we provide details of the data and the methods used to construct it.³ As a general point we should emphasize that the results presented below generally encompass patents granted either by EPO or at least one NPO unless this is otherwise stated. Where patents from the same patent family are granted by both the EPO and the NPO we count both. A detailed analysis of such double patents is relegated to the appendix.

Motivation

The EPO has a unique role within the EPS. It offers patent applicants the service of a one-stop-shop for the process of obtaining a granted patent. Should the applicant obtain a granted patent they must then validate the patent with those national offices (NPOs) in which the patent is to take effect. Validation allows companies to customize the size of the territory within which they wish their patents to take effect. Once companies have validated a patent and started to pay fees to NPOs they can always reduce the territorial extent of protection by allowing their patent to lapse in some countries. They cannot later extend protection to countries in which the patent was not validated after grant. As time has passed and the EPS has expanded to additional countries, firms seeking extensive

territorial protection for their patents would have increasingly found the EPO to be the more attractive office for patent examination and maintenance.

Alternatively companies can submit their patents to one or more NPOs directly. Generally speaking, submitting an application to EPO is more attractive as the number of territories within the EPS in which the patent is to be enforced increases and if the EPO is more likely to grant a patent than some of the NPOs.

This leads us to three questions:

1. Have companies used the EPO with increasing frequency as time has passed?
2. If so, have all types of companies used the EPO with increasing frequency as time has passed? Here we consider country of origin, size of the company and technology focus as dimensions along which we differentiate company type.
3. Is the EPO more or less strict in examining patents than the NPOs and does it examine more or less quickly?

In addition, we extend the analysis of country origin of applicants to show how portfolios of granted patents of companies from France, Germany and Great Britain have developed during the last 3 decades. The comparison reveals strong differences across these three countries that deserve further analysis.

Results

Creation of the EPO simplified the patent application process for companies which sought patent protection in multiple

³ This structure is unusual, as most articles will present data construction and methodological details before providing the main findings. As this paper is mainly descriptive and most of our analysis does not involve statistical or mathematical methods we believe that relegating details of data construction and methods to later sections of this paper is in the interest of our readers.

European⁴ countries. The main advantage was a reduction in costs of obtaining a granted patent. Furthermore, the administrative burden was reduced, as companies negotiate with only one office over the text of the patent application. The main disadvantage of using this procedure is the risk associated with a rejection by EPO. It is conceivable that EPO might reject the patent application while one or more NPOs would not. In practice applicants tend to mitigate the risk of EPO rejection by applying to one NPO before subsequently also applying to EPO. In most cases the national application is later dropped⁵.

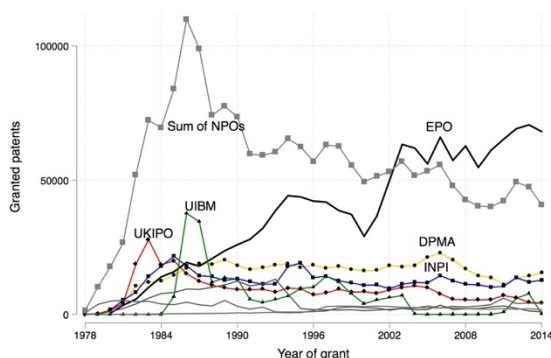


Figure 1: Granted patents in the EPS. Own calculations based on data obtained from PATSTAT 2016. The data exclude utility models (*Gebrauchsmuster*) that are granted by DPMA(DE), OP(AT), UIBM(IT) and OEPM(ES).

Turning to Question 1 we provide two figures. Figure 1 shows the total number of applications that resulted in a granted patent within the EPS. The total number of individual applications resulting in granted patents submitted to EPO has been higher

than the total number of applications resulting in granted patents submitted to the 10 largest national offices⁶ within the EPS since 2002. There is a slight trend for a widening of the gap between the NPOs and the EPO, but there is also clearly a lot of variation, which is driven by relative fees and changes to administrative procedures. The sensitivity of applications to fees set within the EPS is explored in detail by Harhoff, Garanasvili, & von Graevenitz, (2018).

Figure 1 also shows some data for the largest national offices. Their ranking as set out in Table 1 is fairly stable over time, with DPMA (DE), INPI (FR) and IPO UK (GB) granting the highest number of patents. Notice that the data contained in the PATSTAT database on patents granted in Italy is likely to be unreliable.

Since patents granted by EPO are only valid in an EPS member state once they have been validated there, the comparison between patents granted by EPO and patents granted by the NPOs may be unhelpful for some purposes.

Figure 2 provides a comparison between the total level of patents granted by the largest 10 NPOs and the total number of patents validated within the EPS after grant by EPO. The median patent granted by EPO results in 6 validations. Figure 2 shows that once validations are taken into account the EPO grants the majority of patents that are in

⁴ EPO provides patent protection within the EPS territory. Currently EPS includes 38 countries, while it only consisted of 8 member states in 1978.

⁵ We analyse the case of double patents, where the national application is granted in parallel to the EPO application, in the methodology section below.

⁶ The ten largest patent offices by patents granted between 1978 and 2012 within the EPS are set out in Table 1 in the appendix. These comprise DPMA (DE), INPI (FR), UK IPO (GB), UIBM (IT), OEP(AT), OEPM (ES), IGE(CH), RVO(NL), PRV(SE), OPRI (BE).

force in the territory covered by the EPS and this has been the case for three decades.

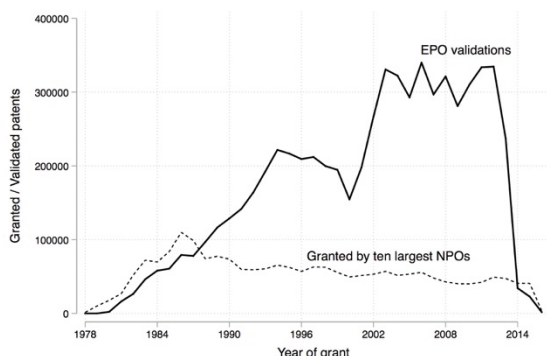


Figure 2: Patents validated within the EPS after grant by EPO. The drop off in validations and national grants after 2014 is the result of grant lags. It does not indicate a real drop in validations and grants.

We explore details of the validation behaviour of companies further below.

Figures 1 and 2 raise the question which types of companies use which offices. This question has multiple dimensions: the size of the company, its country of origin, the technology it focuses on and number of countries within which the company seeks to protect the patent are explored below.

Size of Companies

The size of each company would ideally be measured through assets or the number of employees. This would require a matching between the applicant names from PATSTAT and from company registers. Such a matching exists only very partially and due to the limitations of publicly available company registers it does not extend to the vast majority of patentees. We use the size of the companies' patent portfolios to approximate company size here.

This still requires a significant effort in cleaning and matching company names within PATSTAT. This work is described in the methodology section.

Figure 3 shows which fraction of companies had obtained portfolios of granted patents from either the 10 largest NPOs within the EPS or from EPO by 2010. It shows that the fraction of companies holding a single patent is 63.4% for EPO while it is 69.5% at the NPOs. These numbers are likely biased upwards by our inability to correctly identify all company groups, but there is no reason to assume that the bias is significantly higher in the data from the NPOs.⁷

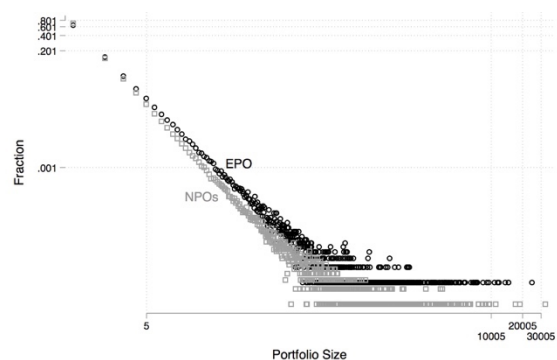


Figure 3: Patent portfolio sizes in 2015 - Log-log plot of fraction of applicants with patent portfolio of a given size based on all patents granted by EPO or NPOs before 2015.

This indicates that the NPOs are somewhat more important for the very smallest companies seeking to obtain patent protection within the EPS. Our data indicate that the fraction of companies holding more than 2 patents in their portfolio is always higher at EPO than at the NPOs. For the owners of very large patent portfolios we are much more likely to have identified the size of the portfolios correctly. Figure 3 also

⁷ If one restricts analysis to European companies only, then the proportion of single patent portfolios at the NPOs rises to 71.1% and remains at 63.8% for EPO.

shows that the largest portfolios at EPO are of a similar size to the largest portfolios within the NPOs. Table 2 in the Appendix lists the owners of the largest 25 portfolios at EPO and within the NPOs. The portfolios are based on the sum of all patents granted by either type of office by 2016. Table 2 reveals that many of the largest companies obtain granted patents from both EPO and some NPOs. It also provides a hint of what might motivate these larger companies to prefer either EPO or the NPOs: large manufacturers of chemical or pharmaceutical products tend to be more frequent in the top 25 applicants at EPO as are large companies not headquartered in Europe. The most significant technology institutes supported by national governments are prominent amongst the top 25 portfolios at the NPOs. Of the companies that are headquartered in Europe many rely on the NPOs as well as EPO.

Country of Origin

Table 3 provides a similar analysis at the level of the country of origin of the applicant company. This table needs to be read with a pinch of salt as the inventors could well have a different nationality from that attached to the company and the patent may well have originated in a research facility in a different country too. Ignoring such details Table 3 shows that companies from the top 5 countries using EPO are also among the companies from the top 6 countries using the NPOs. Italy is the only country not in the top 5 countries of origin at EPO that is in the top 5 countries of origin at the NPOs. Taking this a little further we can analyse the ratio of the number of patents going to the NPOs over those going to the EPO for each country of origin. For Germany

this number is 1.75, indicating that for every patent granted by EPO to a German company 1.75 are granted by an NPO. For France this ratio is 3.07 while for the US it is 0.48 and Japan it is 0.54. Using this metric Spain (10.9), Austria (6.79) and Italy (3.58) are the outliers from Europe. Meanwhile companies from Canada (1.32) and Korea (1.01) behave very differently from those from the US and Japan. This is remarkable as it suggests that companies from some non-EU countries rely much less on the EPO than we might expect.

Some more detail on how companies from different countries use the NPOs is provided in Figure 4. This shows that DPMA is often used by applicants that are not situated in Germany. It also shows that INPI (FR) and IPO UK (GB) are important destinations for patent applications from inside and outside Europe.

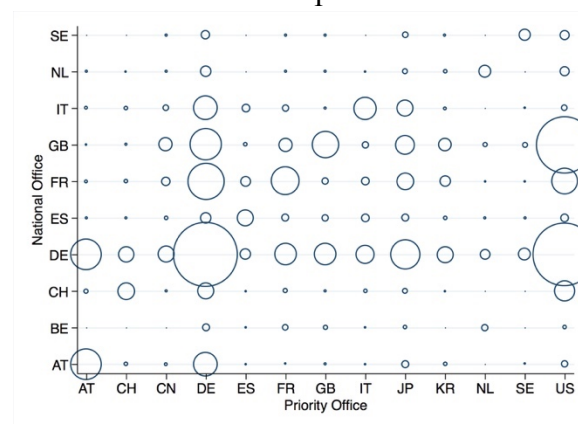


Figure 4: Frequency of patent applications at NPOs (2008-2012). Size of circles indicates how often applicants who first submitted a patent to a priority office (x-axis) then submitted to each NPO (y-axis). Assigning nationality to the company on the basis of priority office is slightly different than relying on country codes for companies themselves. Most often the two are the same.

While US companies prefer IPO UK to INPI by a large margin, Japanese companies are evenly split and German and Spanish companies somewhat prefer INPI.

We do not include a similar graph for the period 1998-2002. Comparison of the above with this second graph reveals that Japanese and US companies reduced the number of direct applications to national offices in the decade between 2000 and 2010.

We can also compare how companies validated patents granted by EPO across national offices. This is done in Figure 5. This reveals that DPMA (DE), INPI (FR) and IPO UK (GB) are the most important offices for validation, mirroring choices made by companies that rely just on NPOs. However, validations at the smaller national offices in Europe are far more significant than direct applications regardless of the origin of the applicant.

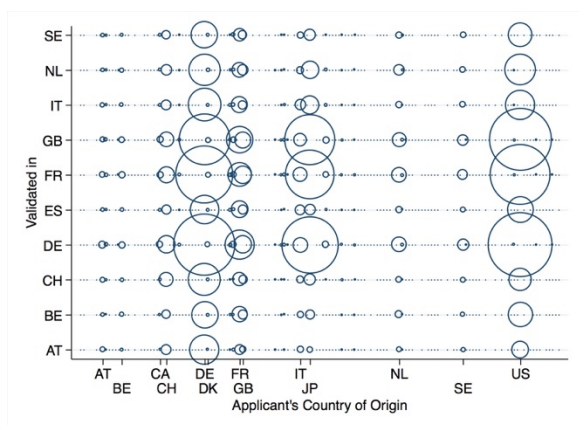


Figure 5: Frequency of validation at NPOs. Size of circles as in Figure 4.

To complete this analysis of the origin of the applicants at EPO and NPOs Figure 6 shows the share of applications at EPO/ the NPOs that arose from companies of a specific country.

Figure 6 shows that the share of applications at EPO due to companies from

Germany, France and Italy steadily increased from 2000 to 2010 while the share of US and Japanese applications at EPO fell significantly. Meanwhile the share of US applications at the NPOs increased slightly and that of Japanese applications fell slightly. Figure 6 also shows that the share of applications due to companies from Great Britain decreased both at EPO and at the NPOs.⁸

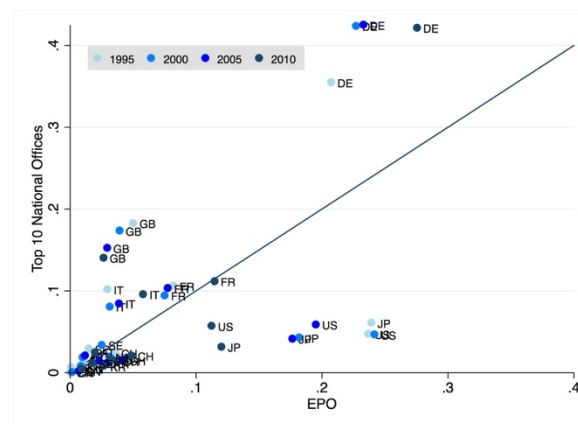


Figure 6: Share of applications at EPO and National Offices in four different years made by companies from countries indicated on graph.

Technology focus

The technological focus of an applicant company cannot be entirely separated from the origin of the company. It has been documented previously that the industrial structure of different capitalist economies varies significantly [Hall & Soskice, (2001); Casper & Soskice (2004)]. Some of the differences in the behaviour of companies from different countries which the previous section documents may therefore arise from differences in industry structure.

⁸ Pure patent counts are generally a very poor indicator of innovation activity, but the simultaneous decline of patents coming from UK firms at all offices in the EU is noteworthy, especially when compared to the experience of France, Germany and Italy in the same period. We provide further analysis of this question in Figures 9,10 &11 below.

Here we begin by showing how these differences in the use of the patent system across industries have evolved over the last 3 decades. The patent system is frequently divided into 5 large and 35 more disaggregated technology areas.⁹ Figures 7 and 8 show first that the share of patents granted by EPO increased from zero to substantial shares between 1978 and 1998. Thereafter shares stabilized.

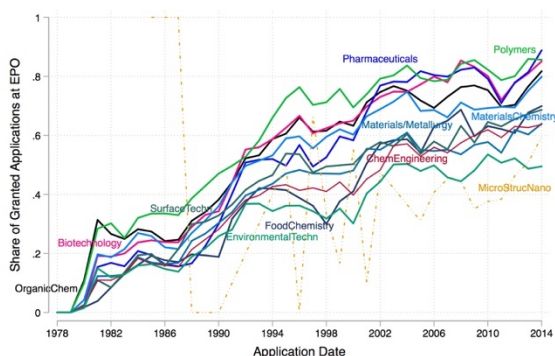


Figure 7: Share of **Chemistry** patents granted by EPO out of all patents granted by EPO and NPOs by technology area.

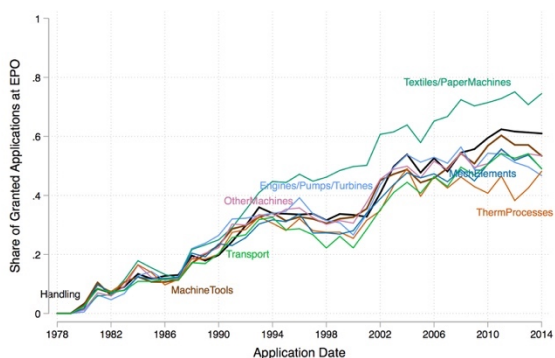


Figure 8: Share of **Mechanical Engineering** patents granted by EPO out of all patents granted by EPO and NPOs by technology area.

Comparing the two largest main areas, Chemicals (22.5% of all patents granted in Europe) and Mechanical Engineering (34.5%) it emerges above all that a larger share of Chemicals patents is

granted by EPO while the share of Mechanical Engineering patents granted there has increased to just above 50% only in the last decade.

These averages hide a wide range of variation: in Chemicals approximately 80% of all patents granted in Europe are granted by EPO while only around 50% of patents in Environmental Technology are granted by EPO. Similarly, around 70% of patents in Textiles and Paper Machines are granted by EPO but only around 40% in Thermal Processes.

The main explanation for this difference is likely to be the ease with which innovations protected by patents in Chemistry can be reengineered and manufactured and the relatively greater costs of exploiting innovations protected by patents in Mechanical Engineering. This is also evident when comparing how widely patents are validated when they are granted by EPO. We turn to this aspect in the following section.

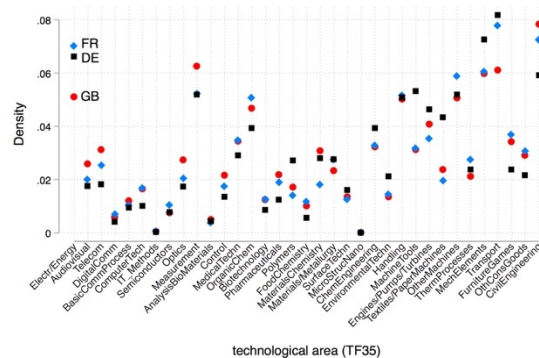


Figure 9: Density of patents granted in the EPS in 35 technology areas by country of origin. For each country the symbol is higher, if the share of patents in a technology area out of all patents granted to firms from that country is greater.

⁹ The scheme according to which patents are sorted into these technologies is provided by Schmoch (2008).

First, we return briefly to the question of industrial structure by comparing patenting behaviour of firms from Germany, France and Great Britain. Figure 9 shows which technology areas each country had the largest exposure to prior to 2000 – with Great Britain having a larger share of its patenting than France and Germany in Audiovisual, Telecom, Optics, Measurement, Control, Pharmaceuticals, Materials Chemistry and Civil Engineering.

Figure 10 analyses how patenting grew between 1990-2000 and 2004-2014 for each technology area.

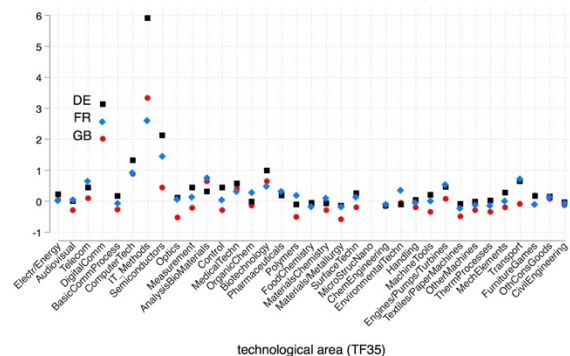


Figure 10: Growth rate of granted patents across 35 technology areas by country of origin within the EPS. The growth is based on the decade 1990-2000 compared to the period 2004-2014.

The figure clearly shows that patenting growth by companies from Great Britain lagged behind that in France and Germany over this period in almost all technology areas. Of the technology areas which the UK was comparatively more focused on prior to 2000 only Pharmaceuticals and Civil Engineering have at least a growth rate of patenting on a par with the other two economies. There is not a single technology area in which the growth rate of UK patenting exceeded that of France or Germany during this period. This

underscores the findings from the aggregate data reported in Figure 6.

While this type of analysis is suggestive one may remain sceptical of it. For instance, the reader may be aware of the fact that many innovations protected by patents that are in force are not sold on the market or used in production. In other words, they exist only in order to prevent others from marketing these innovations. Having observed this fact, it might be that applicants from Great Britain are generally less likely to hold such patents in their portfolios. To address this possibility Figure 11 is based only on patents receiving at least 6 citations within five years of publication in patents issued by EPO. Economists have found repeatedly that citations to patents provide a rough indication of the economic impact of the cited patents [Moser, Ohmstedt, & Rhode (2017); Trajtenberg (1990)]. A focus on these very highly cited patents should therefore provide some indication of the ability of each of these economies to generate significant innovations.

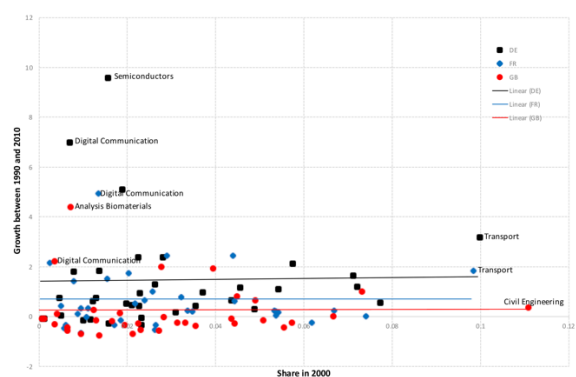


Figure 11: Highly Cited Patents: Each point is a technology area. On the x-axis we plot the share of highly cited patents in the area out of all highly cited patents granted to companies from that country in 2000. On the y-axis we plot the growth in highly cited patents in that area between 1990 and 2010. The lines are regressions of the growth of patenting on the importance of each sector. These reveal that

the average growth of highly cited patents across sectors was highest in Germany and lowest in Great Britain.

In Figure 11 we combine the approach of the previous two graphs by plotting the within country share of highly cited patents granted in 2000 in each technology area on the x-axis and the growth in highly cited patents in each area and country between 1990 and 2010 on the y-axis.¹⁰

The result is very similar to that of the previous graphs: companies from Great Britain have grown the number of highly cited patents at a lower rate than companies from France or Germany over the two decades between 1990 and 2010. It matters little whether a technology area accounts for a large or small share of patents in each country's portfolio of highly cited patents.

When considering why these results emerge it may be worth taking into account that these three economies are of a different size. Next, we show how many highly cited patents each country generated in Europe per constant trillion, year 2000 US dollars of GDP. Table 1 demonstrates that relative to the size of the economy Great Britain has for a long time produced fewer highly cited

patents than either France or Germany. Note that in this period the manufacturing share of GDP in France and Great Britain declined from around 16% to 10%. Meanwhile in Germany it has remained at around 20%. The explanation for the large difference in the number of highly cited patents generated between France and Great Britain cannot be due to this factor.

	DE	FR	GB
1990	1967.30	2533.35	1172.60
2000	2259.04	1862.38	808.99
2010	3108.78	2707.56	828.28

Table 1: Highly cited patents per trillion, constant 2000 US \$. Data on GDP from OECD.¹¹

It is well documented by OECD that both public and private R&D investment levels in the UK have been significantly lower than those in France or Germany since the early 1980's.¹² The findings we outline here suggest that this difference in R&D investment has had a material effect on patenting by companies from Great Britain.¹³ What we do not know is whether this has also affected their productivity and thereby wealth and growth in Great Britain. Overall the

¹⁰ In response to a query based on this analysis Stuart Graham [Georgia Institute of Technology, and formerly Chief Economist at the United States Patent & Trademark Office (USPTO)] analysed patents granted by USPTO to companies from Germany, France and Britain. His results confirm that British companies did not obtain increases in patents granted by USPTO that are comparable to companies from France or Germany after 2005.

¹¹ The same ranking emerges from the EU's Science, Research and Innovation Performance of the EU (SRIP) report 2018 where PCT patent applications are used (https://ec.europa.eu/info/sites/info/files/srip-report-chap-1-4_2018_en.pdf).

¹² One way of demonstrating this is to look at the share of R&D in gross domestic spending in GDP in these countries: <https://data.oecd.org/chart/5iz4> (last accessed on 17.9.2018). A similar picture emerges when only the Business financed share of R&D is considered. A recent report by IPO UK provides additional detail on UK investments in R&D (IPO UK, 2017).

¹³ Hall B. , Helmers, Rogers, & Sena, 2013 document that rather few companies in the UK use the patent system. A recent report by EU IPO on trade secrets and patenting shows that the proportion of firms relying on patents in Germany is 20% points higher there (47.8% v 27.3%): <https://bit.ly/2tPjawW>

analysis suggest that a detailed analysis of this question is warranted.

Number of Countries

The focus of this section is the number of countries in which each patent granted by EPO is validated. In the previous section we showed that the share of patents in Europe granted by EPO is higher on average in Chemistry related technologies than in those of Mechanical Engineering.

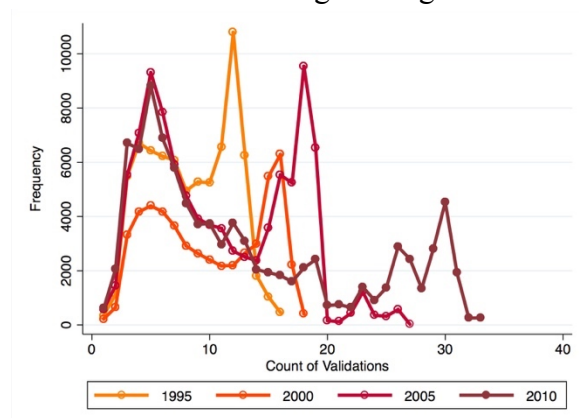


Figure 12: Chemicals - Distribution of validations by year.

One explanation for this is the greater need to protect innovations in Chemistry in each country in Europe to prevent parallel imports. This means that the advantage from using EPO is felt particularly keenly by companies that require a wide territorial coverage for their patents.

Figure 12 shows that as the number of member states within the EPS increased over time so did the number of countries in which firms validated patents in Chemistry. The distribution of validations is bimodal in this field: one set of patents is validated on average in six countries, whilst there is a second maximum close to or at the maximum number of countries in which a patent can be validated. This maximum increases over time as more countries join the EPS.

In contrast patents granted in Mechanical Engineering have continuously been validated in 4 or 5 countries on average as is shown in Figure 13. There is a tail reaching the maximally possible number of validations, but the number of cases for which this tail is reached is quite small.

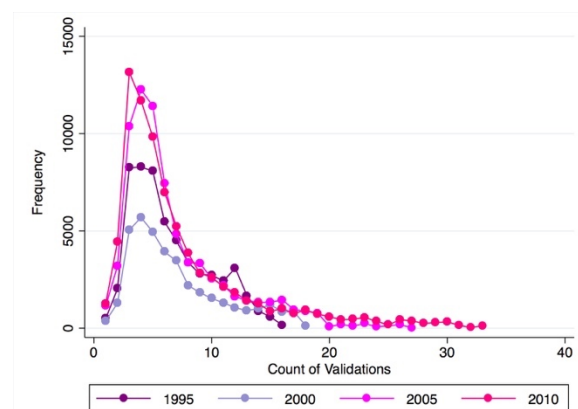


Figure 13: Mechanical Engineering - Distribution of validations by year.

Figures 4 and 5 above indicated that some countries are more frequently chosen as places to validate a patent than others. The Figures also revealed that companies which patent only at NPOs prefer the same countries as those using the EPO. Most frequently these are Germany, France and Great Britain, which we refer to as the core countries.

Figures 14 and 15 below provide an insight into the combinations of countries which applicants rely on most frequently when validating patents in the EU. The choice of the set of countries in which to validate can be seen as a vector in the space of countries: the validation vector. Figure 14 shows how frequently the most popular such vectors were used. It shows that after the mid 90s the most frequently used validation vector is the core countries (DE, FR, GB). More recently combinations of the core with Italy have also become popular.

The figure also shows that earlier in the history of the EPO many patents were validated in a much larger set of countries, which we refer to as the “main” set of countries. Occasionally applicants validate only in a subset of the core, usually Germany and one of the other two countries – the increased popularity of the combination of Germany and France over the combination of Germany and GB most likely accounts for why more companies now validate in France than in Great Britain.

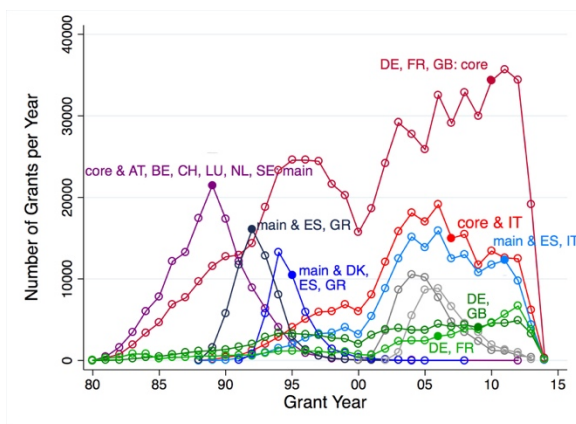


Figure 14: Validation vectors at EPO based on patents granted by EPO and validated in at least one country within the EPS.

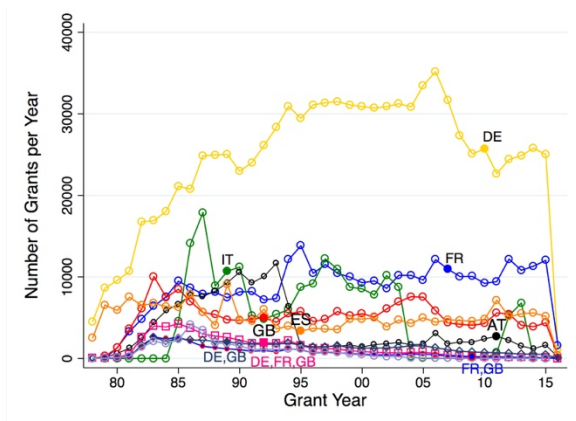


Figure 15: National application and grant vectors.

Usually we would expect companies that are only seeking patent protection in two European countries to rely on the NPOs. Figure 15 shows that cases in which this

arises are quite rare. The vast majority of patents granted by the NPOs do not have a second or third patent in the family that is granted by another European NPO. Where such patent pairs do arise, they usually get filed at the offices of the core countries noted above.

Examination Durations and Grant Propensity

Whenever a company intends to protect its patent only in a few select countries, the decision whether to apply to EPO or a set of NPOs may be driven by the probability that the patent will be granted or by the length of time it takes the office to grant the patent. These two variables are interrelated: offices that examine a patent in great detail may take longer to grant everything else being equal. In addition, the company applying for the patent may have an interest to obtain a patent grant very quickly or more often as late as possible. The longer the company can keep the final version of the patent document open, the more opportunities it has of adapting that text to cover commercially valuable applications. This means that the following figures present data that are the result of patent office procedures and company choices. This makes it hard to draw firm conclusions from these figures about the performance of the offices.

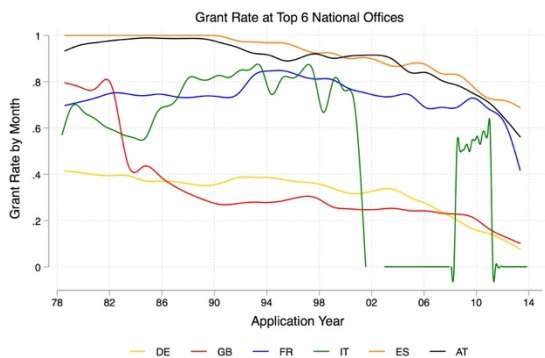


Figure 16: National office grant rates by year of patent application.

We begin by comparing the grant rates of the six largest NPOs. Figure 16 shows that while DPMA and IPO UK are tough venues for applicants, the other four offices (INPI (FR), UIBM (IT), OP(AT) and OEPM(ES)) grant large proportions of patents submitted to them. There may be many reasons for these differences – quality of applications may differ across offices just as much as office procedures do¹⁴.

Turning to Figure 17 it becomes apparent that the EPO had a lower granted rate than the four “lenient” NPOs and higher grant rate than DPMA and IPO UK. The figure 17 also reveals that French and German applicants who used EPO had about the same rate of success there over time, in spite of the significantly different grant rates at the respective national offices. Assuming that examiners at EPO applied the same criteria to patents, this may go some way to explaining why the ratio of national patents to EPO patents held by French firms (3.07) is

almost double that of German firms (1.75). British firms, like their German competitors face a tough domestic office, but also had a harder time to obtain patents at EPO than French or German firms.

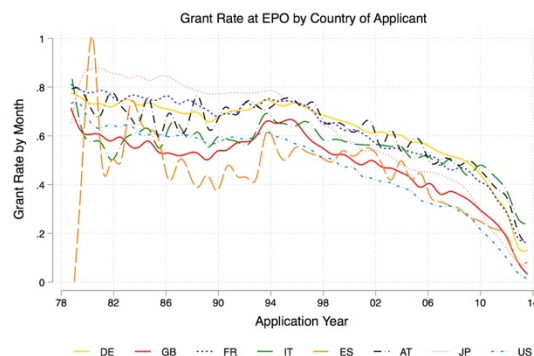


Figure 17: Grant rates at EPO by country of applicant.

This may be partly due to industry composition, but it is interesting to note the stability of the difference in grant rates between German/French and British firms as the EPO became stricter after 1996. Note also that while the grant rate for Italian applicants at EPO was similar to that for British applicants until 1996, it is now much closer to that for French, German or Austrian applicants.

¹⁴ While DPMA (DE), IPO UK (GB), OEPM (ES) and OEP(AT) examine patents substantively, INPI(FR) and UIBM (IT) register patents for which a search report is published. Nonetheless INPI grants fewer patents submitted to it than either OEPM or OEP. More detail on different offices' approaches to examination and search are provided by EPO at this site (<https://www.epo.org/applying/national.html>). WIPO has published an informative policy guide on search and examination (http://www.wipo.int/edocs/pubdocs/en/wipo_pub_guide_patentsearch.pdf).

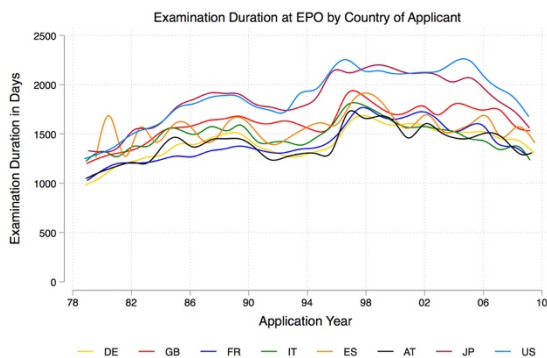


Figure 18: Examination duration at EPO by country of origin of the applicant.

The reason for the fall in the grant rates at EPO can be found in the increase in applications and resulting longer examination durations at EPO in the 1990s. This led to calls for reform that ultimately resulted in lower grant rates as seen in Figure 17. Figure 18 shows that examination durations at EPO increased sharply for patents submitted around 1995, regardless of the country of origin of the applicant.

Meanwhile the examination duration at NPOs was significantly lower throughout this period, even at the “tougher” NPOs in Britain and Germany. It is hard to imagine that this was due solely to differences in applicant behaviour. Note that Figure 19 reveals that applications at INPI were granted more quickly than those at DPMA and IPO UK over almost the entire period under consideration, just as one would expect, if INPI was being less exacting of applicants than the other two offices. Data for UIBM (IT) reported here is suspect as is also the case for Figure 16 above.

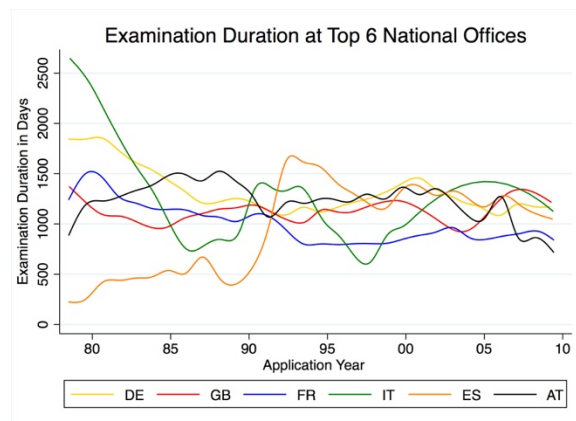


Figure 19: Examination duration at NPOs

Summary and Discussion

The EPS has operated in its current form since 1978. In this time there has been a shift of patenting away from the NPOs towards EPO. The volume of patent grants has remained high at the largest NPOs indicating that many companies obtain a valuable service from these NPOs. This paper has documented that some applicants use both the EPO and the NPOs in parallel. Harhoff, Garanasvili, & von Graevenitz (2018) show that fee changes at EPO or NPOs induced some applicants to switch between EPO and the NPOs. They also show that this affects the examination durations of patents submitted by other companies. In sum these results show that within the EPS the largest NPOs and EPO are complementary institutions: where one becomes less attractive companies can fall back on the other. It seems highly likely that this applies not just to fees but also to examination duration and examination quality.

To date the patent granting institutions within the EPS do not coordinate fee setting, hiring of examiners or the examination procedure they apply. This lack of coordination leads to externalities that

create costs for companies using the EPS. Our analysis suggests that the EPS could contribute better to the productivity of the European economy if greater coordination were achieved. Our analysis does not suggest that the NPOs are redundant.

Data and Methodology

In this section we provide some more detail on how the data we use was constructed. We also discuss some results we obtained on parallel patenting within the EPS.

Cleaning and Matching Applicant Names

To link applicants' names across offices we standardized and aggregated portfolios within the EPO and the national data separately. Having completed this step, we then linked portfolios across the two datasets. Standardisation and aggregation proceeded in four steps: first, we standardized all names, cleaning out punctuation marks and standardizing legal forms¹⁵; next we aggregated portfolios within the EPO data and the national data using a file derived from Derwent's encoding of patent applicants¹⁶; third we aggregated all remaining patents using standardized names. Finally, we then checked the largest remaining portfolios and assigned these to firm groups identified previously, where this was appropriate.

The remaining patents were assigned to firms on the basis of firms' standardised names. Overall, we have 521564 separate

firms in the data with 82078 in the EPO data and 521533 in the national office data.

Linking of portfolios across the two main datasets (EPO and national offices) proceeded in three steps: first, we appended the national data to the EPO data, next we linked the firm group identifiers from the national data to the EPO data for all those instances in which patents in the same patent family existed at EPO and national offices and we had either assigned the same Derwent code or the same standardized name to both patents. We then extended the national firm group identifiers to all EPO patents within the firm groups at EPO.

We checked the results of this procedure by inspecting the standardized names in the largest ten portfolios thus created. Next, we manually checked the largest portfolios of patents within EPO that we had not assigned a national firm identifier and manually attached such identifiers on the basis of firms' names where appropriate. Finally, we created firm identifiers based on standardised names for those firms in the EPO data that had not yet been assigned a firm identifier.

Overall there are 3,524,218 granted patents in the dataset we have constructed.

Double Patenting

One quirk of the EPS is the possibility that one patent application submitted to one or more NPOs and to the EPO may be granted by both. Due to differences in procedures the patents are not usually granted at exactly the

¹⁵We used files originally created by Bronwyn Hall and Christian Helmers for this. We are grateful to them for sharing these files.

¹⁶¹⁵ This file contains code to identify company groups. We found 4094 firm groups in the EPO data and 5684 firm groups in the national office data. As the firm sets don't overlap entirely we have 5905 separate company groups in our data.

same time. When the same patent is granted by EPO and an NPO it is theoretically possible that the owner obtains two versions of the patent in one jurisdiction. National patent laws in Europe differ as to what happens next: in Germany and France the national patent automatically loses validity when the EPO patent is finally granted, while in several other jurisdictions the national patent (e.g. Austria, Sweden) both patents remain valid.

Double patents arise for good reasons: as illustrated in Figure 18 EPO takes longer to grant than the NPOs on average. Some applicants may therefore prefer to obtain an earlier national grant, while wrangling with EPO over the final text of the patent that is then extended to EPS member states and the home country.

We have found that almost 69% of double patents are granted by either DPMA (79,334) or INPI (94,554) for patents with an application date before 2011. Figure 20 shows that the vast majority of such cases are those for which the national grant date precedes that at EPO. The median difference is around 2 years for patents first granted by DPMA, INPI and UIBM. It may be interesting to note that the examination duration at EPO of patents for which a national patent is granted is shorter by almost 1 year than that of patents for which no national patent is granted. The portfolios of firms that obtain double patents tend to be smaller on average than those of firms that drop the national applications before grant. Both findings suggest that double patents are a form of insurance for smaller applicants.

15% of patents granted by DPMA and 23% of patents granted by INPI were

subsequently also granted by EPO in the period we study.

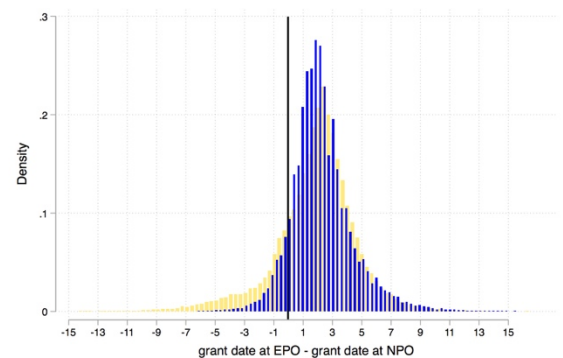


Figure 20: Difference between grant date at EPO and grant date at INPI(blue)/DPMA(yellow) in years for patents granted by both EPO and the NPO.

Bibliography

- Casper, S., & Soskice, D. (2004). Sectoral systems of innovation and varieties of capitalism: explaining the development of high-technology entrepreneurship in Europe. In F. Malerba, *Sectoral Systems of Innovation: Concepts, Issues and Analyses of Six Major Sectors in Europe*. (pp. 348-387). Cambridge: Cambridge University Press.
- Hall, B., & Helmers, C. (2018). *The impact of international patent systems: Evidence from accession to the European Patent Convention*. NBER.
- Hall, B., Helmers, C., Rogers, M., & Sena, V. (2013). The importance (or not) of patents to UK firms. *Oxford Economic Papers*, 603-629.
- Hall, D., & Soskice, D. (2001). *Varieties of Capitalism*. Oxford: Oxford University Press.
- Harhoff, D., & Hall, B. (2012). Recent Research on the Economics of Patents. *Annual Review of Economics*, 541-565.
- Harhoff, D., Garanasvili, A., & von Graevenitz, G. (2018). *Patenting Strategies in the European Patent System*. London: CGR.
- Harhoff, D., Hoisl, K., Reichl, B., & Van Pottelsberghe de la Potterie, B. (2009). Patent Validation at the Country Level: The role of Fees and Translation Costs. *Research Policy*, 1423-1437.
- Harhoff, D., Hoisl, K., Vandeput, C., & Van Pottelsberghe de la Potterie, B. (2016). Languages, Fees and the International Scope of Patenting. In *Palgrave Handbook of Economics and Language* (pp. 403-422). Springer.
- IPO UK. (2017). *Building the Evidence Base on the Performance of the UK Patent System*. London: The Intellectual Property Office.
- Mejer, M., & van Pottelsberghe, B. (2012). Economic Incongruities in the European Patent System. *European Journal of Law and Economics*, 215-234.
- Moser, P., Ohmstedt, J., & Rhode, P. (2017). Moser, P., Ohmstedt, J. and Rhode, P.W., 2017. Patent citations—an analysis of quality differences and citing practices in hybrid corn. *Management Science*, 1926-1940.
- Plomer, A. (2015). A Unitary Patent for a (Dis)United Europe: The Long Shadow of History. *International Review of Intellectual Property and Competition Law*, 508-533.
- Schmoch, U. (2008). Concept of a Technology Classification for Country Comparisons. In *Final Report to the World Intellectual Property Organization (WIPO)*. Fraunhofer Institute for Systems and Innovation Research, Karlsruhe.
- Trajtenberg, M. (1990). A penny for your quotes: patent citations and the value of innovations. *Rand Journal of Economics*, 172-187.
- Van Pottelsberghe de la Potterie, B. (2014). European Patent System. In *Encyclopedia of Law and Economics*.

Tables

Table 1

Granted patents by office

Office	Nat	1982	1992	2002	2012	1978 - 2013
EPO	EP	5638	32021	49891	69154	1236951
DPMA	DE	10468	17406	18201	13547	529360
INPI	FR	8257	11286	9579	13673	415143
IPO UK	GB	18664	9380	9090	6222	326768
UIBM	IT	11	4465	6260	6023	223660
OP	AT	3894	11358	1845	2299	161991
OEPM	ES	4723	2719	1550	4060	105758
IGE	CH	1892	1882	972	449	65178
RVO	NL	84	696	2966	1972	48594
PRV	SE	9	34	2700	977	37396
OPRI	BE	4039	7	0	0	33910
Total		57679	91254	103054	118376	3184709

Note: This table lists the number of patents granted by the 10 largest NPOs within the EPS (by total grants) in the years 1978-2012. Notice that the Belgian office has not granted patents since 1988 and is included here by virtue of the volume of patents granted prior to that year. The table is ordered by the total number of patents granted between 1978 and 2012.

Table 2

Largest Portfolios at EPO and NPOs

Company	Patent Stock	Company	Patent Stock
SIEMENS	24846	SIEMENS	33210
ROBERT BOSCH	14684	ROBERT BOSCH	19095
PHILIPS	14676	DAIMLER	17223
BASF	13679	MITSUBISHI	11790
MATSUSHITA EL.	11969	PEUGEOT CITROEN	11108
CANON	11696	VALEO VISION	9682
BAYER	10868	L'OREAL	9550
IBM	9539	RENAULT	8931
SONY	9205	GENERAL ELECTRIC	8845
HITACHI	8384	PHILIPS	8290
TOSHIBA	7384	SAMSUNG	7622
ERICSSON	7383	COM. A EN. ATOMIQUE	7584
SAMSUNG	7270	HONDA	6401
DU PONT	7256	MANNESMANN	6155
HONDA MOTOR	7188	AIRBUS	6138
TOYOTA	7144	INFINEON	5793
3M	6893	SONY	5467
FUJITSU	6827	THOMSON CSF	5215
GENERAL ELECTRIC	6703	FRAUNHOFER GES	5160
NEC	6477	ALCATEL	4776
ALCATEL	5680	RHONE POULENC	4559
EASTMAN KODAK	5580	CANON	4528
FUJI PHOTO	5540	ABB	4405
HOECHST	5098	AUDI	4174
NOKIA	5094	INST. FR DU PETROLE	3962

Note: This table lists the largest portfolios of patents granted by EPO and the NPOs. In bold those companies that are not listed on the other side of the table. This does not imply that those companies have no patents granted by EPO/ an NPO. Only that those portfolios are too small to put the company in the top 25.

Table 3
Largest Countries Portfolios at EPO and NPOs

Rank	EPO		NPOs	
	CC	Count	CC	Count
1	US	316395	DE	530764
2	DE	303732	FR	357929
3	JP	260988	IT	167997
4	FR	116440	US	153160
5	GB	57510	GB	148179
6	CH	54200	JP	142578
7	IT	46932	AT	109864
8	NL	42986	CH	83222
9	SE	30818	ES	74683
10	AT	16173	NL	53768
11	KR	15721	SE	44164
12	CA	15011	BE	29750
13	BE	13367	AU	19875
14	FI	12893	CA	19770
15	DK	10069	KR	15842
16	ES	6851	TW	10371
17	AU	6609	FI	7691
18	CN	5641	SU	7055
19	IL	5074	HU	5416
20	NO	4300	DK	4904

Note: CC stands for Country Code. The countries in bold are those from outside Europe. SU, stands for Soviet Union. Hardly any patents were granted with this code after 1998.