The Role of Fees in Patent Systems: Theory and Evidence

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The role of fees in patent systems: Theory and evidence*

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Abstract

This paper reviews the economic literature on the role of fees in patent systems. Two main research questions are usually addressed: the impact of patent fees on the behavior of applicants and the question of optimal fees. Studies in the former group confirm that a range of fees affect the behavior of applicants and suggest that a patent is an inelastic good. Studies in the latter group provide grounds for both low and high application (or pre-grant) fees and renewal (or post-grant) fees, depending on the structural context and on the policy objectives. The paper also presents new stylized facts on patent fees of thirty patent offices worldwide. It is shown that application fees are generally lower than renewal fees, and renewal fees increase more than proportionally with patent age (to the notable exception of Switzerland and the U.S.).

Keywords: application fees, patent system, price elasticity, intellectual property policy, renewal fees
JEL Classification: O30, O31, O38, O57

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1 Introduction

> "*After being confronted with the existence of renewal fees, an economist might first ask how they are set, or what an optimal renewal fee schedule should look like. Somewhat surprisingly this issue has been discussed very little.*" (Pakes and Simpson, 1989, p. 334)

Patent is supposed to be an essential tool to foster innovative efforts. The monopolistic power it confers aims to compensate for the weak appropriability of the returns to innovative activities, thereby pushing private level of investment in research and development (R&D) closer to the socially optimal level. Yet, patent systems have recently been put under high pressure and their good functioning is questioned. Patent filings have soared, resulting in severe backlogs, especially at the U.S. Patent and Trademark Office (USPTO). Additional worries are related to the quality of incoming patent applications which is often said to have substantially decreased. Scholars nowadays talk about a "broken" patent system (Jaffe and Lerner, 2004).

In this context, it is particularly important to understand the policy tools available to patent offices and how they could be used to fix the patent system. One such tool is the fee policy. The high heterogeneity in the schedule of fees observed across patent offices worldwide, as well as the recent moves towards more expensive patents, raise the question of the role of fees in patent systems.

Discussions on fees were so far mostly confined to the circle of civil servants who staff patent offices and patent lawyers. In the words of Watson (1953, p. 712), U.S. Commissioner for Patents, this latter group "*is not only familiar with the problems of the various clients whom it represents but has an intimate knowledge of and a lively interest in the workings of and welfare of our patent system and the USPTO.*" Yet, the question of how fees can help shape a proper patent policy should be of interest to all stakeholders of the patent system. Endorsing Jaffe and Lerner (2004)'s thought, "*patent policy is too important to leave to the patent lawyers.*" In addition to providing insights to policymakers, understanding the role of fees is also relevant for the growing number of scholars who use patent data but often ignore the price considerations concerning patenting. Although taxes on fuel, alcohol and cigarettes are all important determinants of the demand for these products, patent fees are often assumed — wrongly so — to play no or a limited role in determining the demand for patents.

The objective of this paper is twofold. First, it provides new stylized facts on the historical evolution of patent fees and on current cross-country differences in the level and the structure of fees. Second, it takes stock of the economic literature on the role of fees in patent systems. Studies on patent fees, which have only appeared recently, usually address two main research questions. A first body of works is mostly concerned with estimating the impact of fees on applicants' behavior, while a second mainly tackles the issue of optimal fees. As a broader objective, the paper intends to raise awareness among economists and policymakers that fees matter. They can be used to fine tune patent systems and must be accounted for when using patent data.

The paper is organized as follows. The next section provides an historic overview of the prevalent mindset in patent offices with regard to fees. Section 3 presents long-term series on the evolution of fees at the USPTO as well as an up-to-date picture of fees schedules across thirty patent offices. The statistics gathered illustrate the high heterogeneity in patent fees — both in their level and in their structure — across patent offices. Section 4 surveys the studies that look at the effect of fees on the behavior of applicants while Section 5 summarizes the literature on optimal fee setting. The final section concludes, draws some policy implications and highlights areas of future research. The reader who is not acquainted with the patent process may refer to Appendix A to have a schematic description of the fees that must be paid over the live of a patent.

2 Historical perspective on the setting of fees

It seems that debates on patent fees have frequently come up to the fore. In answer to an address of Watson to members of the American Patent Law association on October 13, 1953, Fisher (1954, p. 82), a patent lawyer, notes: "*As the Commissioner brings out, the question of what fees should be charged by the [US] Patent Office for performing its various functions has been of some concern for over 100 years.*" Today's discussions on the international patent scene echo these of the fifties. At that time, indeed, concerns about the increasing backlog and the quality of examination were serious and the appropriate level of patent fees was already discussed (Fisher, 1954). Patent fees are generally applicant friendly and their setting appears to be governed by the imperative to balance budget or to adjust to the level of other patent offices. For instance, the UK patent office must be self-financing since 1991 and must achieve a rate of return on capital that is set by the Treasury (Gans et al., 2004). Similarly, the Patent and Trademark Office Corporation Act of 1995 established the USPTO as a wholly owned Government corporation with the requirement to be self-sustaining. The political will to make patent offices self-sustaining is not new. The Patent Act of 1790, which was the U.S.' first patent statute, set fees at around $5 corresponding to roughly $2,300 in today's money using the unskilled worker wage deflator.[1] This amount was an "*[...] intentionally low rate, sufficient to cover simply the cost of issue.*" (Watson, 1953, p. 713). The adjustment to international standards is a second important objective pursued when setting fees. Three years later, indeed, the Patent Act of 1793 dramatically increased the fees at $30, which amounts to $10,700 in today's money for an unskilled worker. This reform made the U.S. more comparable to European systems, which involved the imposition of substantially higher fees (Watson, 1953). On the British side, Nicholas (2010) underlines that the 1883 reform of patent laws was also pressed on the basis of international discontinuities in

[1] See Patent Act of 1790, Ch. 7, 1 Stat. 109-112, Sec. 7. (April 10, 1790). Conversion rates for the dollar come from L. Officer and S. Williamson (2008), Measures of Worth, available on http://www.measuringworth.com.

patent fees.

The setting of renewal fees, which are due on a regular basis to maintain a granted patent in force, follows the same imperatives. In the words of Federico (1954, p. 845), "*the main purpose of the annual [i.e., renewal] fee is to derive revenue to defray the expenses of administering the patent office.*" Post-issuance fees allow to lower application fees, thereby encouraging the filing of patents since "*the heavier burden of the fees falls after a patent has been in force for some time and the patentee would be better able to pay than at the beginning when the application is filed.*"

These two mechanisms, the imperative of a balanced budget and the adjustment to other patent systems, suggest that applicant's behavior and welfare considerations are seldom taken into account by policymakers. It is probably due to a common wisdom that fees do not influence patent practices. Since the actual fees to be paid to patent offices are a fraction of the overall cost of securing a patent, intuition leads policymakers to think that changes in fees do not really affect patentees. This intuition is well captured by U.S. Senator McClellan's quote, chairman of the patent subcommittee, on the Patent Office Fee Bill of 1964 which more than doubled the fee rates: "*In view of the fact that all other expenses involved in securing a patent, most notably legal fees, have increased since 1932 without any reduction in the number of applications filed, the committee does not agree that the adjustment of fees provided in this bill will discourage invention.*"[2]

Policymakers have only recently realized that patent fees can be used as a policy tool. This change in attitude is well illustrated by three communications by officials of the EPO in a few years interval. In May 2000, Gert Kolle, Director for International Legal Affairs at the EPO, declared that two of the main challenges for the EPO were to cope "*with a rapid increase in patent applications*" and to find "*effective means for reducing patenting costs.*"[3] Gert Kolle further adds "*In total, EPO fees have decreased by around 41%, and I believe we have now reached the point were the potential savings that can be made in patent office costs have been exhausted.*" There was a clear intent to make the patent system more affordable. In 2007, however, Alison Brimelow, President of the EPO, held a drastically different position: "*What I'm running up the flagpole is 'why are we not asking people to pay what it costs to come into the patent system'? We've got huge backlogs, huge volumes — and the funding model is ending its shelf life.*"[4] This change in attitude is further witnessed by Ciaran McGinley (2008, p. 28), the then Controller of the EPO, who implicitly acknowledge that the EPO is partly responsible for the "global patent warming" through its inappropriate fee policy in the nineties: "*The starting point is the rather obvious economic statement that behaviour is influenced by costs. Costs include fees. There is some evidence that fee levels on their own do also influence behaviour. Generally, one can say that low fee levels can be seen as an incentive for certain*

[2] 89th Cong., S. Rept. No. 301 cited in Cohen (1972).

[3] Interview by Richard Poynder, for Thomson Reuters. "Discussion of European Patent System", May 2000.

[4] Financial Times, November 23, 2007.

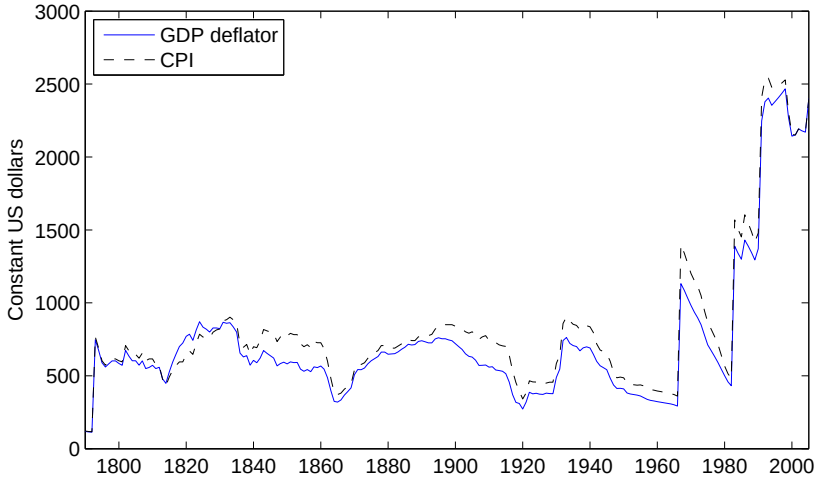
types of behaviour and high fee level as a disincentive." Policymakers seem thus to be aware that fees might play a role and are keen to develop a sound fee policy.

The next section sheds light on past and present policy choices made by patent offices. It presents the evolution of application fees at the USPTO since its inception in 1790 and compare the current fee policy of thirty patent offices worldwide.

3 Stylized facts

Figure 1 and Figure 2 show the evolution of application fees at the USPTO over a period of more than 200 years. The series presented in Figure 1 are deflated using either the GDP deflator or the consumer price index (CPI). Fees have been roughly stable until the end of the sixties at around $600 but have severely increased since then: current fees at the USPTO reach an all-time high.

Figure 1: Evolution of application fees at the USPTO in constant (2005) U.S. dollars, 1790-2005.

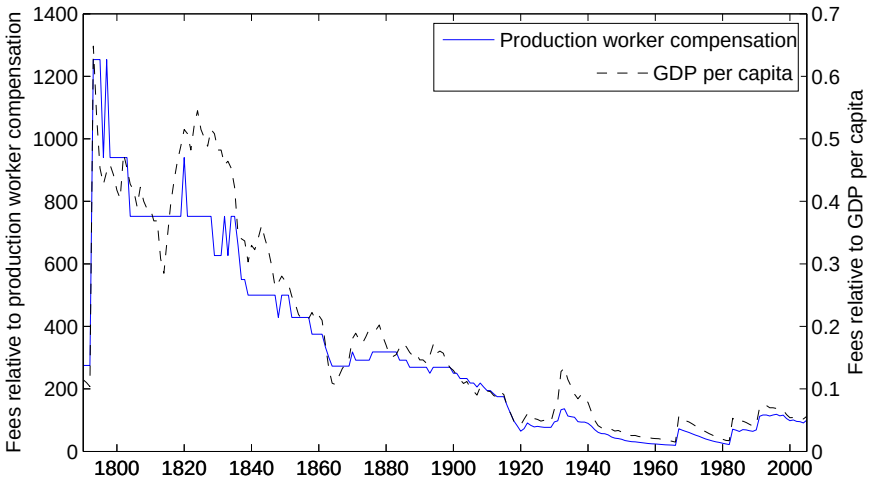


Sources: Series used to adjust fees to current level come from L. Officer and S. Williamson (2008), Measures of Worth, available on http://www.measuringworth.com. Data on fees have been collected from various sources: Patent Act of 1790; Patent Act of 1793;Patent Act of 1836; Patent Act of 1839; Patent Act of 1870, Patent Act of 1922; House Report No. 96-1307, 96th Cong., 2d Sess. (1980); Fisher (1954); de Rassenfosse and van Pottelsberghe (2008); Landes and Posner (2004); Watson (1953).

However, these measures of price do not give a fair idea of how affordable patents were in the past. If a representative inventor could expect to earn $100

in today's equivalent money in 1790 but $10,000 in 2000 with its invention, then a $10 patent in 1790 in today's equivalent price is relatively more expensive than a $100 patent today. For this reason, the series in Figure 2 are deflated using two income indicators: the average wage of a blue-collar worker, and the per-capita GDP. When the wealth of individuals is controlled for, current patent fees are at an all-time low, suggesting that the U.S. patent system has never been so affordable. Current fees would need to increase approximately tenfold to match their 1800 level.

Figure 2: Evolution of relative application fees at the USPTO, 1790-2005.



Notes: Fees are weighted by proxies of the population's wealth (production workers' compensation and GDP per capita). Sources: see Figure 1.

The second set of data collected aims at comparing current fees across patent offices worldwide. This exercise serves two purposes. First, it can be used to compare the level of fees across jurisdictions. Second, it allows understanding the type of fee schedules that patent offices have adopted: low or high application (or pre-grant) fees versus low or high renewal (or post-grant) fees. Two indicators of fees were computed: fees up to the grant and renewal fees. In what follows we assume that it takes on average four years to grant a patent (renewal fees up to the fourth year, if any, are included in the pre-grant fees indicator). Post-grant fees include renewal fees from the fifth year to the twentieth year of protection.

Three metrics can be used for international comparisons. The first one simply consists in comparing absolute fees in a currency of reference. The top panel of Figure 3 presents absolute fees in international U.S. dollars (US PPPs). It provides a good approximation of the cost applicants have to incur. There is

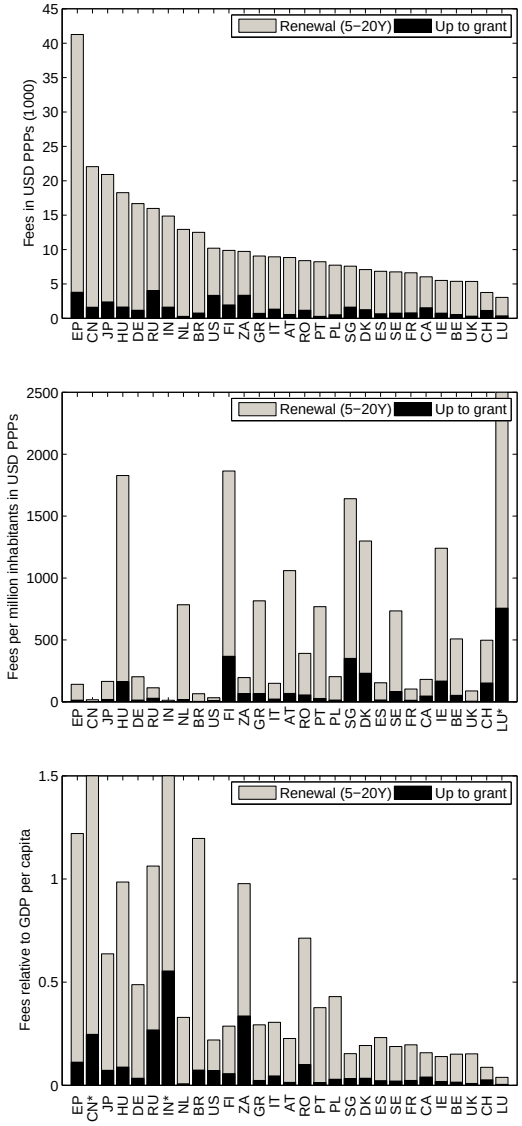
a high heterogeneity across patent offices, both in terms of the total fees and in terms of the mix between fees up to the grant and renewal fees. Total fees vary from 3,755 US PPPs for Switzerland to 20,918 US PPPs for Japan. The fees for the EPO are computed for the six most frequently targeted countries (DE, FR, GB, NL, IT, CH). Procedural fees at the EPO are by far the most expensive, nearly twice as much as fees at the JPO.[5] The second metric, depicted in the middle panel of Figure 3, consists in weighting fees by the market size covered by the patent office. For instance, fees in Finland are similar than fees in the US, but one can conclude that the Finish market is more expensive to protect in relative terms, because it is smaller in size than the U.S. market. The ranking dramatically changes when a relative measure is considered. China and Japan, two of the countries with the highest absolute fees, are among the cheapest on a per-capita basis, and nordic countries are among the most expensive. The third metric captures how affordable patents are. Fees presented in the bottom-panel of Figure 3 are divided by the GDP per capita. The measure leads to a ranking that is different from the two previous ones, although Hungary remains in the group of the most expensive countries. France, the UK and the U.S. are among the most "affordable" systems whereas China and India are by far the most expensive. Fees at the European patent office are also among the highest, together with Brazil, Russia and South-Africa.

Figure 4 provides a detailed insight into the current structure of fees adopted by patent offices. The x-axis represents the ratio between yearly renewal fees and yearly fees up to the grant. The closer to 0 the more the burden is put on application fees. It is worth noting that the index is greater than unity for most patent offices, meaning that yearly pre-grant fees are generally lower than yearly post-grant fees. This is particularly true in the Netherlands and Portugal where renewal fees are much higher than pre-grant fees. The U.S., South Africa, Switzerland, Canada, Singapore and Russia, on the contrary, have yearly renewal fees that are lower than yearly pre-grant fees. The ratio between late renewal fees (from the eleventh to the twentieth year) and early renewal fees (from the fifth to the tenth year) is depicted on the y-axis. All but one patent offices are above unity, indicating that fees to be paid on the first five years after grant are proportionally lower than fees to be paid in the last ten years. In other words, renewal fees increase more than proportionally with patent age. The countries with the sharpest increase are Germany and Greece, where late renewal fees are about five times higher than early renewal fees. Note that most countries are in the top-right corner of Figure 4, which means that fees by and large increase with patent age. The USPTO, situated in the bottom-left corner, clearly stands apart: fees actually decrease with patent age.

Table 1 brings an alternative view of the structure of fees. The patent offices are grouped according to the level of fees up to the grant and post-grant relative fees. The grouping is performed for both absolute fees and renewal fees.

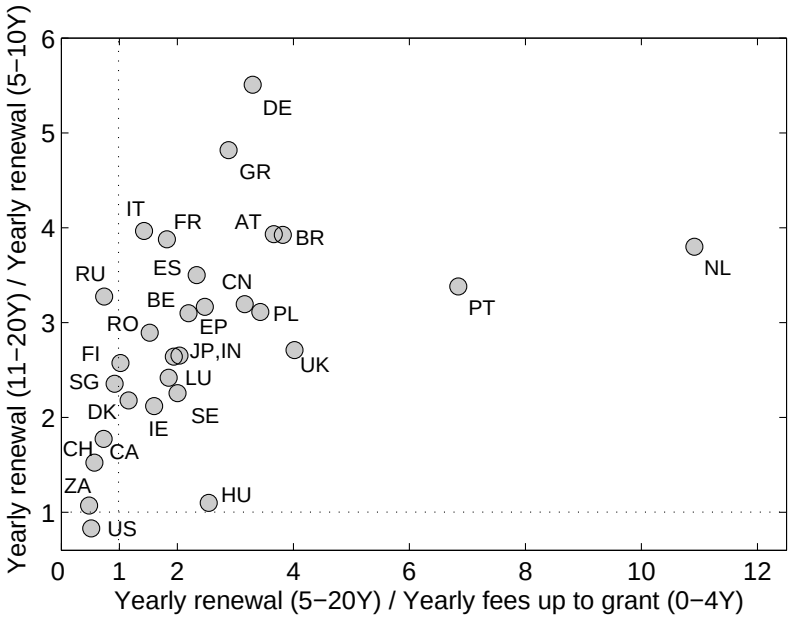
[5]Note that EPO fees are a lower bound estimate because they do not include translation fees. See van Pottelsberghe and Mejer (2010) for recent computations of total patenting costs

Figure 3: Fees up to the grant and post-grant fees across patent offices, 2010.



Notes: Middle panel: the figure for Luxembourg was capped to at $2,500 but amounts to $6,352. Bottom panel: the figures for China and India were capped at 1.5 but amount to 3.37 and 5.07 respectively. Fees for EP are computed for the six most-frequently targeted countries (DE, GB, FR, NL, IT, CH). Sources: Fees were collected on patent offices' website. Data on the GDP and the exchange rate (local currency to US PPPs) come from the IMF World Economic Outlook database. See Table 3 in Appendix A for absolute fees in EUR.

Figure 4: Overview of the structure of fees.



Sources: See Figure 3.

Table 1: Policy choice regarding pre- and post-grant fees.

	Post grant fees (year 5 to 20)			
	Absolute (USD PPPs)		Relative to capita	
Fees up to grant	*Low*	*High*	*Low*	*High*
Low	LU, IE, BE	NL, GR	IN, CN, US	
High	SG	EP,CN,JP	ZA	LU, HU, FI

Notes: Fees in a country are considered "low" ("high") if they are in the first (last) 1/3rd lowest fees.

Fees in a country are considered "low" ("high") if they are in the first (last) third of lowest fees. Some countries such as Belgium and Ireland have opted for a cheap patent system. In these countries, indeed, fees up to the grant and post-grant fees are among the lowest. Other countries, on the contrary, are among the most expensive for both types of fees. These include China, Japan, and the EPO. Interestingly, the Netherlands and Greece have low pre-grant fees but charge post-grant fees that are among the highest. The high heterogeneity in the fees schedules put in place by patent offices shows that there is no typical structure. The next two sections summarize the main findings on the impact of fees on the behavior of applicants and on the optimal fee policy.

4 Impact of fees on applicants' behavior

A first strand of the literature looks at the impact of fees on the behavior of applicants. Studies can be divided into four main categories: descriptive papers and early hypotheses, evidence from survey data, econometric analyses of the impact of pre-grant fees, and econometric analyses of the impact of post-grant fees.

4.1 Descriptive papers and early hypotheses

The first studies on patent fees were essentially descriptive (Federico, 1954; Helfgott, 1993). Scholars were interested in comparing the various fees across patent offices worldwide. Federico (1954), for instance, reviews fees charged by the largest patent offices with a particular focus on renewal fees. At that time, indeed, the U.S., one of the few countries that did not charge post-issue fees, was reexamining its patent fees. It was considering introducing maintenance fees to be paid at regular intervals after the patent had been granted.

Despite the lack of empirical evidence, some scholars raised the idea that fees may partly explain differences in patenting rates across countries. Pavitt (1985, p. 83), in a review of the pitfalls associated with international comparisons of patent data, writes: "*[...] the greater number of Japanese patents awarded to Japanese residents, than of US patents to US residents, probably owes more to the relatively low cost of Japanese patenting than to any extraordinarily high productivity of Japanese industrial R and D activities.*" In a study of the share of inventions that are patented, Arundel and Kabla (1998, p. 138) think that the difference in the propensity rates they obtain for Europe compared to the rates obtained for the U.S. by Mansfield (1986) could be due to "*[...] lower costs of applying for a patent in the US compared to Europe, both in terms of the actual application fees and in terms of the relative market size per unit application cost.*"[6] A graphical validation of this idea is put forward by van

at the EPO.

[6]Others factors than fees may explain the differences in patenting propensity rates across countries. Japanese applicants tend to file many narrow applications rather than a few broad ones as it is more common in the U.S. (Kotabe, 1992), in addition other policy instruments (de

Pottelsberghe and François (2009) who show a negative relationship between patent cost per claim per capita (the 3C-index) at the USPTO, the JPO and the EPO and the number of claims filed in these offices. This typical demand curve is a first illustration that fees could help to understand differences in the patenting behavior of applicants across countries.

4.2 Survey studies: never "cheap" enough

Early evidence on the impact of fees can be found in surveys of applicants, R&D managers or IP professionals. In every survey, a sizeable share of the respondents report that patent fees are expensive and that they hinder the use of the patent system. A study by the EPO (1994, p. 157) indicates that 45% of the applicants questioned find procedural fees at the EPO to be expensive or very expensive and 44% thinks that renewal fees in Europe are too expensive. This is particularly true for small companies, which are more critical of EPO fees. Other surveys carry the same message. Cohen et al. (2000) report that 40% of U.S. manufacturing firms in their sample mentioned high applications cost as a reason for not patenting. The high cost of patents is the first motive not to patent in a survey of Swiss biotechnology companies (Thumm, 2004). Similarly, 40% of large Belgian firms surveyed in Peeters and van Pottelsberghe (2006) state that patent fees are too high. Graham et al. (2010) find that cost considerations loom large for U.S. startups in deciding to forego patenting: the cost of getting a patent is the most frequent reason cited for not patenting a technology.

The survey results point in the direction of a sensibility to fees, but they do not allow one to get an exact idea of the magnitude of the effect that fees have. In addition, these findings must be taken with a pinch of salt, as it is natural for firms to complain of the level of fees. The empirical investigation of Peeters and van Pottelsberghe (2006) actually shows that there is no significant correlation between a strong perception that patents are expensive and the observed size of a firm's patent portfolio. In a study of the determinants of the proportion of inventions patented in French manufacturing firms, Duguet and Kabla (1998) report a similar result. They find that neither patenting costs nor the costs of legal action have a significant effect on the propensity to patent. These results illustrate the limitations of survey studies.

Comparative analyses, early hypotheses, and surveys were as many warning signs that called the attention of economists to start deeper investigations on the role played by fees.

4.3 Pre-grant fees

A patent office can already have an influence at the drafting stage with specific fees, most notably claim-based or page-based fees. The policy change orches-

Rassenfosse and van Pottelsberghe, 2009) or heterogeneous degrees of rigor in examination processes (as suggested by Guellec and van Pottelsberghe, 2007, or Lemley, 2000) may all substantially affect the propensity to file patents.

trated by the USPTO in December 2004 is an interesting natural experiment on the impact of a change in the fee policy. The drastic raise of claim-based fees at the USPTO (from $18 per claim in excess of 20 to $50) had a significant impact on the number of claims filed, as observed by Archontopoulos et al. (2007). From an average of about 28 claims per patent before the fee increase, the relative size of applications has fallen to about 23, leading to a price-elasticity of about -0.20.[7] These results are of importance in the current context of high backlogs and delays in the grant process. Indeed, as illustrated by Lazaridis and van Pottelsberghe (2007), from an average of 11 claims per patent, two additional claims lead to an additional communication from the EPO to the applicants, and one additional communication leads to an additional year of delay in the expected grant date. In other words, claim-based fees affect the speed of examination in two ways: A first order effect that reduces the amount of information to be processed by examiners and a second order effect that lowers the need for interaction with the applicant.

Application fees are a second type of fees that affect patent filings. The effect of application fees on the demand for patents is mostly analyzed by means of patent production functions. Unfortunately, most of the studies capture the cost of patenting in a manner that does not allow estimating fee elasticities. Sanyal (2003), for instance, models cost for the applicant with a set of patent office attributes, including fees. Although the proxy of the cost is found to influence patenting activity, her results cannot be used to derive the elasticity. Similarly, Eaton and Kortum (1996) find that the cost of applying for a patent, including agents' fees and translation fees, has a negative impact on the patenting activity. Yet, their estimated parameter cannot be used to measure the fee elasticity as it captures other monetary costs. Other papers look at the impact of patent fees outside the convenient framework of patent production functions. Eaton et al. (2004), for instance, find that 60% of the increase in the number of EPO patents over the nineties can be attributed to the decline in the overall cost of seeking protection at the EPO.

To the best of our knowledge, nine studies report formal estimates of the fee elasticity of demand for patents or allow to infer it.[8] MacLeod et al. (2003) and Nicholas (2010) examine the change in total applications before and after the 1883 Patents Act in Britain, which led to a substantial reduction in the cost of obtaining a patent. Before the reform, patent fees were £25, a very high amount for that time corresponding to half a year's wages for a skilled worker. With the reform, fees fell by 84 percent, to £4, and the number of granted patents jumped by roughly 150%, suggesting a price (arc) elasticity of -0.66. Interestingly, this increase in patent applications was associated with a decrease in patent quality. Nicholas (2010) finds that the increase in the propensity to patent by British inventors was "*concentrated in the low value distribution of*

[7] We report arc elasticities, defined as [(x2-x1)/(0.5x1+0.5x2)]/ [(y2-y1)/(0.5y1+0.5y2)]. Arc-elasticities are more robust to large change in parameters value.

[8] The work by Wilson (2008) must also be mentioned for the sake of completeness. Using application data at the USPTO from 1970 to 2006, the author finds an elasticity of -0.10. He suggests raising application fees up to $50,000 for large businesses.

patents" as measured by renewal data.

In a study of 8,000 historical inventions that were exhibited at 19th- and 20th-century world fairs, Moser (2009) finds that 11.1 percent of the inventions exhibited in Britain were patented against 15.3 of the inventions in the U.S. Compared with (constant) fees for carrying a patent to full term of $37,000 in Britain and $612 in the United States, the author computes the price elasticity of demand for patents to be around -0.16 in 1851. This figure is subject to much caution as it is only a rough approximation that does not take into account other institutional differences between the U.S. and the UK such as the strength of patent systems or procedural differences. In addition, it is estimated on the basis of the amount to be paid if the patent is carried to full term, i.e., the maximum amount of fees that can be collected for a patent. Application fees would have probably been a more appropriate indicator than total cumulated fees.

The first econometric evidence of fee elasticity is owed to Adams et al. (1997) who model the annual number of patent applications at the USPTO over the period 1959 to 1991. They obtain a short-term elasticity of application fees of -0.12 and find no significant long-run impact of fees. A second quantitative analysis is performed by Landes and Posner (2004). The authors explain the number of U.S. patent application from 1960 to 2001, controlling for patent fees with a weighted average of the large-entity and small-entity fees. The elasticity they obtain is very low (-0.03) and marginally significant.

The studies presented so far are confined to the U.S. and the UK. de Rassenfosse and van Pottelsberghe (2007, 2009) have estimated the impact of patent fees on the demand for priority patent applications on cross-sections of countries for the year 2003. Estimating fees on a comparable basis is not straightforward, as the structure of fees greatly differs from one country to another. Beyond the fact that each patent office has its own nomenclature and granting requirements, pricing schemes are specific to each country. The timing of fees also matters, as applicants might be asked to pay fees at various stages of the patenting procedure. The authors adopted a methodology that consists in computing a single fee indicator that encompasses all fees to be borne up to the grant by applicants. The indicator was computed for a representative patent in each patent office, characterized by a certain number of claims, pages and drawing pages. The authors then analyze the effects of the cumulated fees up to the grant by means of a traditional patent production function to control for other broad determinants of patenting such as the strength of patent systems or the productivity of research (as for instance captured by R&D spending per researcher). They find that fees have a negative and significant impact on the number of first filings. The estimated parameter fluctuates around -0.50, implying that an increase of 10 percent in fees would lead to a decrease of 5 percent in the total number of patent applications. Note that de Rassenfosse (2010) uses the fees presented in de Rassenfosse and van Pottelsberghe (2007, 2009) to study the impact of patent fees on the propensity to patent at the firm level. Using data from an international survey of industrial firms, he shows that applicants in countries with high patent fees have a lower proportion of their invention portfolio that

is patented.

de Rassenfosse and van Pottelsberghe (2008) estimate the price elasticity at the trilateral offices (EPO, JPO and USPTO) over 26 years with dynamic panel-data models. This approach is useful for two reasons. First, the elasticity estimated from cross-sectional data is potentially inaccurate, because it implicitly assumes no or low adjustment costs such that a change in any exogenous variable leads to an immediate adjustment in the number of patent filings. The estimate of the price elasticity is supposedly very sensitive to this issue as patent fees are volatile by nature. Second, it is useful to look at these three particular offices since they face the biggest challenges both in terms of the increase in patent filings and in terms of backlogs. The authors obtain a long-term elasticity fluctuating around -0.30. The short-term (contemporaneous) elasticity is much smaller and stands between -0.06 and -0.12.

4.4 Post-grant fees

Patent offices can also influence the life of a patent once it is granted through validation fees and yearly renewal fees. Validation fees are peculiar to the European patent system. After grant, a European patent must be validated in each Member States for which protection is desired by the applicant. The validation process requires the payment of national validation fees as well as a translation of the patent in the country's official language. A quantitative assessment of the relationship between the fees/costs and the validation behavior of applicants is analyzed at the macroeconomic and the microeconomic levels by Harhoff et al. (2009a) and Harhoff et al. (2009b) respectively. In the former study, the authors rely on an econometric gravity model to explain aggregate validation flows from applicant's country to the validation country. They control for the size of the two countries (the number of inhabitants), their wealth (the GDP per capita), their distance, the level of validation fees, the early renewal fees (up to the 6th year), and qualitative information on translation costs. The major factors affecting the cross border flow of patents are the size and the wealth of the origin and the destination countries. The distance between capital cities and the age of EPC membership of the destination country are additional significant determinants. Finally, validation and early renewal fees are found to have a substantial negative impact on the validation behavior of applicants, with an elasticity of about -0.30.

A richer analysis of the validation behavior of applicants is presented in Harhoff et al. (2009b), who model applicant's decision to seek patent protection in a given country at the patent level. In addition to the aggregate factors presented above, the authors control for patent characteristics (number of claims, number of forward citations and size of applicant's patents portfolio) as well as other market characteristics. They confirm that validation fees and early renewal fees are important determinants of the decision to validate a patent in a country. An increase in the validation fees by 1% leads to a decrease in the validation probability of 5.3%, whereas a 1% increase in early renewal fees leads to a decrease in the validation probability of 13.7%.

Note that both studies find that translation costs significantly reduce the share of patents that are validated in a jurisdiction. As a matter of fact, the European market is expensive to cover, especially when compared to the U.S. or Japan. van Pottelsberghe and Mejer (2010) report that translation costs account for half the total cost of patenting for a patent that is to be validated in 6 EPC Member States.[9] They also estimate that the recently ratified London Agreement, which aims to reduce the translation requirement for patent validation procedures in 14 out of 34 national patent offices, has reduced the cost of patenting by 20 to 30%. The countries that put the London Agreement into force are expected to experience a substantial increase in the number of validation. Overall, Harhoff et al. (2009b) predict that national patent validations may increase by as much as 29% for those countries. Yet, despite the substantial cost savings, the relative cost of a European patent validated in six (thirteen) countries is still at least five (seven) times higher than in the U.S. according to van Pottelsberghe and Mejer (2010).

The studies by Harhoff et al. (2009a,b) give a first insight into the impact of renewal fees. That early renewal fees impact the decision to validate a patent in a country suggests that applicants plan to maintain their patents in force in the validated country at least for a few years after the grant date. In-depth investigations of the impact of renewal fees on renewal rates can be found in Schankerman and Pakes (1986) and Danguy and van Pottelsberghe (2009). In an attempt to estimate the private value of patents rights in post-war Europe, Schankerman and Pakes (1986) use renewal data and obtain the elasticity of renewal fees on the share of patents maintained in force as a side result. They find that a one percent increase in renewal fees decreases the proportion renewed by about 0.02%. Other authors have also used patent renewal data to estimate the value of patent rights but do not report estimates of fee elasticities (e.g., Deng, 2007). A specific estimate of the impact of renewal fees on the maintenance rate is owed to Danguy and van Pottelsberghe (2009). They estimate the impact of renewal fees on the aggregate maintenance rate of patents for 15 European countries, the U.S. and Japan. They find that a € 1,000 increase in renewal fees increases the drop-out rate by 12 percentage points. Given that renewal fees rise over time, and that the maintenance rate logically decreases, the implied elasticity mechanically increases over time. Our computations suggest that the elasticity of the maintenance rate with respect to renewal fees is -0.03 at year 6, -0.08 at year 10, -0.25 at year 15 and -0.80 at year 20.[10]

The above studies suggest that patent is an inelastic good and provide a range of estimates of the elasticity of various types of fees. However, they are silent on the adequate level of fees that patent offices should charge, as well as on the schedule that they should adopt. The studies presented in the next

[9] According to van Pottelsberghe and Mejer (2010), procedural fees at the EPO before the London Agreement amounted to € 6,385 and translation costs to € 6,224 (Table 8). With the London Agreement, translation costs fall to € 2,576.

[10] At year 3, given a mean level of renewal fees at €115 and a mean maintenance rate at 0.63, a €100 increase in fees leads to a decrease in the renewal rate by about 0.012. Hence, the elasticity is computed as follows: [(0.618-0.63)/((0.63+0.618)/2)]/[(215-115)/((115+215)/2)].

section bring some elements of answer to these questions.

5 In search for an optimal fee policy

Since the early theoretical investigations on patent systems, most landmark papers have essentially focused on two major aspects of policy making: the optimal length and the optimal breadth of patent protection (or the optimal combination of these two dimensions). For instance, Gallini (1992) analyzes the optimal length of a patent according to the cost of imitation. Klemperer (1990) examines the optimal scope of protection whereas Gilbert and Shapiro (1990) identify the optimal mix between length and breadth of patents. Scotchmer (1991) focuses on how patent scope may affect cumulative inventions and hence the speed of diffusion of new knowledge. Studies on the optimal fee policy are scarce, which may be due to the fact that most contributions on the effectiveness of patent systems were motivated by changes in the U.S. patent system. Since fees have been rather low, authors seem to have chosen to focus on more controversial policy leverages related to the length or to the breadth of protection.

Most of the works devoted to patent fees have appeared during the last decade. Pioneering studies focus on post-grant fees and are due to Scotchmer (1999) and Cornelli and Schankerman (1999). Scotchmer (1999) shows that the patent renewal system is equivalent to a direct revelation mechanism whereby higher value inventions receive longer patents. Using a principal-agent framework with two unobservable parameters, a cost of R&D and a signal of the innovation's value, she finds that it is an optimal mechanism when the cost of R&D is a convex function of the value of the project, that is, when the R&D cost of high-value innovations is proportionally higher than the cost of low-value innovations. When the costs and benefits are independently distributed, the optimal renewal system is one where the patent life is fixed.

The contribution by Cornelli and Schankerman (1999) comforts the findings by Scotchmer (1999). In their framework, one firm has an unobservable one-dimensional parameter that determines both the value of the innovation and the amount of money the firm will spend achieving it. They show that an optimally differentiated patent scheme, whereby the patent office offers a menu of patent lives and associated upfront fees, improved upon the optimal uniform patent policy. Any uniform patent life will provide too much incentive to low R&D-productivity firms and too little to high-productivity ones. A renewal scheme further improves upon lump-sum payment when there is post-patent learning effect, that is, when a firm learns about the value of its invention after patenting.[11] The authors use simulation analysis to illustrate the key features of the optimal differentiated patent mechanism. Their results indicate that optimal renewal fees must rise sharply with patent life and more rapidly than the associated profits from the patent. The authors also compare the patent lives and fees from the optimal mechanism with existing statutory patent lives and

[11] Note that post-patent learning is not the only reason that calls for a renewal scheme. The inability of small companies to pay the full fees upfront is another.

fees in France, Germany and the UK. They find the schedule of fees implemented in these countries to be suboptimal: optimal renewal fees should rise much more with patent length than what they observed.

Hunt (2006) provides some insights on the impact of the level of application fees. Using a model that considers both the incentives to invest in R&D and to apply for patents, he shows that reducing the cost of obtaining patents may result in less R&D. This counterintuitive effect arises when intellectual property rights sufficiently overlap as is the case in industries that tend to advance through cumulative innovation such as electronics, computers, and semiconductors. Generally speaking, however, low application fees are seen as socially optimal, especially if the market potential of the invention cannot be well assessed by the time the patent application is filed. This reasoning is endorsed by Gans et al. (2004), who show that the socially optimal fee structure is one where the initial patent application fees are as low as possible (ideally zero) and the renewal fees is as high as possible subject to encouraging invention (i.e., such that the inventor is just willing to undertake the inventive activity ex-ante). Low entry fees insure that no invention with high market potential is lost, as inventor will always apply for patent protection. High renewal fees avoid excessively long patents from a social perspective. The authors also show that when patent offices are bound by budget constraints the fees structure may deviate from this social optimum. The schedule of fees will be flatter than the socially optimal fees, with increased application fees and decreased renewal fees. The intuition is that a self-funding patent office has an incentive to encourage (too) many renewals. It does so, the argument goes, by lowering renewal fees, which increases inventor's expected profit, and this profit is appropriated by the patent office through initial application fees. This financial constraint creates two detriments to social welfare as it discourages the filing of some patents and extends the effective life of others.

The above investigations say little about the actual levels at which patent offices should set renewal fees. Baudry and Dumont (2009) attempt to overcome this limitation by simulating the optimal renewal fees in a real option model where applicants have private but incomplete information at the date of the patent application and learn about the value of the rent as time goes. Using data from the French patent office, they use their theoretical framework to find a Pareto improving schedule of fees that lowers the social cost of patents without deterring innovation compared to the actual schedule. They measure social cost as the expected monopoly rent accruing to the patent holder. They find that the optimal profile is characterized by lower renewal fees until age 14 then a sharp increase to reach a final renewal fee that amounts to about € 3,700, more than six times the current level in France. This profile reduces the social cost per patent by € 127 but also lowers patent office's budget: the renewal fees paid to the patent office fall by more than half. Note that this schedule is in line with Cornelli and Schankerman (1999) who argue that renewal fees must rise sharply with patent age. However, if the requirement to balance budget is added to the constraint, the optimal profile becomes closer to the actual one and does not generate any gains in terms of expected social costs. In a different

manner than Gans et al. (2004), Baudry and Dumont (2009) thus demonstrate that the revenue constraint faced by patent offices distorts the socially optimal schedule of fees. The authors then ask whether it is possible to improve upon the existing schedule by proposing a menu of alternative profiles which discriminate patents ex-ante by the expected market size. They find that the optimal profile for patents with a small initial market size has very low renewal fees up to the tenth year then has a sharp increase in fees. In contrast, the profile for patents with a large initial market size starts at a higher level but increases more slowly. This mechanism whereby applicants self-select the initial market size is appealing from a theoretical perspective but is difficult to implement in practice.

Marco and Prieger (2009) add a supplementary consideration to the literature. They look at the optimal application fees with a congestion model of the patent granting process. They point that the argument that low application fees should be adopted because it is difficult for applicants to know in advance the commercial value of innovations does not account for the cost of the congestion externality, that is, the cost of delay on current applicants. In this respect, the authors consider that patent applicants pay two costs: the direct cost of application, and the indirect cost of waiting in the queue. Their model suggests that application fees can be used to offset this delay cost to a point. The direct effect of raising the fee discourages applications, while the indirect effect is that with fewer applications overall, the expected time to approval falls, increasing the present value of a granted patent. In short, they argue that higher fee is good for the firms as long as it reduces the cost of congestion more than proportionally. Using a grant rate of 50%, the authors estimate that the private value maximizing application fee at the USPTO is approximately $6,000, which is 6 times higher than current application fees. An important limitation of this model is related to the assumption that applicants support "*indirect costs of waiting in the queue.*" Palangkaraya et al. (2008) show that the firms which believe that their application has a low probability of success will actually delay the decision to request patent examination, that is, they purposefully create uncertainty. Similarly, the evidence at the EPO shows that many applicants actually adopt drafting styles aiming at delaying the grant date, because the system becomes prohibitively expensive after the grant of the patent (see Stevnsborg and van Pottelsberghe, 2007, for a detailed list of drafting styles and interactions modes used by applicants to delay the grant date). Future studies on the cost of pendency at patent offices should also consider the point of view of competitors and acknowledge that a "patent pending" protection is valuable to its owner.

To sum up, the literature provides grounds for both low and high fees, depending on structural factors and the socioeconomic objectives pursued by policymakers. Table 2 lists the strengths and weaknesses of the possible schedules of fees. Note, however, that these attributes depend to a significant extent on the institutional context. For instance, it is not always true that high application fees hamper innovation (see Hunt, 2006).

Table 2: Strengths and weaknesses of low and high fees.

	Strengths	**Weaknesses**
Pre-grant fees		
Low	- Applicant-friendly	- Incentive for low quality patents
	- No high-potential invention is lost	- Possible congestion
		- Hampers innovation if high overlap
High	- Self-selection	- Barrier for SMEs
	- Reduce backlogs	- Hampers innovation
	- Budgetary sustainability	
Post-grant fees		
Low	- Applicant-friendly	- (Too) many patents enforced
	- Reward to innovation	- High social cost
High	- Effective revelation mechanism	- Not (large) business friendly
	- Budgetary sustainability	- Hampers innovation

6 Concluding remarks

In the current context of an apparent decline in the quality of patents and of congested patent offices due to a record number of applications, it is worth looking at the tools available to policymakers to fix the patent system. One such tool is the fee policy, which has received increasing attention over the past ten years. The paper starts by presenting key statistics on patent fees across thirty patent offices. Two key findings must be emphasized. First, relative fees at the USPTO have been decreasing for 200 years. Over the years, U.S. patents have become more and more affordable. Second, comparisons of patent fees across a large number of patent offices show that yearly application fees are by and large lower than yearly renewal fees, and renewal fees increase more than proportionally with patent age. Switzerland and the U.S. are among the rare countries where yearly renewal fees are lower than yearly pre-grant fees.

Three lessons can be learned from the present survey. First, the institutional context and the political objectives greatly influence the fee structure adopted by patent offices. There is indeed no such thing as a universally optimal fee schedule. For instance, the statement that renewal fees must rise sharply with patent life actually depends on the time needed to assess an invention potential. An uncertain technological or economic outcome would justify relatively low and flat renewal fees for some years. In a similar vein, no consensus emerges regarding the optimal level of application fees. If no information is available by the time of filing to assess the commercial value of the invention, it is generally considered that application fees should be set low. On the other hand, if the congestion of the patent system is high or if rights overlap to a significant extent, then high entry fees may be preferable. Considerations such as the severity of the backlog or abusive behavior by firms are thus important to set the fees

schedule. Additional information such as the market size covered by a patent system should also be considered, as the value of patent protection is higher in larger markets. Generally speaking, a fee structure must be devised so as to create the right balance between the private incentives to invest in research and the social cost induced by monopolistic rights.

A second lesson learned is that the estimates of the fee elasticity are always lower than unity, indicating an inelastic demand for patent. This finding witnesses the fact that patents are a necessity to businesses and has an important implication for the budget of patent offices. Because an increase in fees lowers the demand by a smaller relative amount, higher fees would actually increase patent offices' budget. Note that an inelastic demand does not imply that patent fees is a ineffective policy tool. It however means that a change in fees must be sufficiently large to have observable effects.

Third, and more generally, the literature review has emphasized the need for more economic studies in this area. On the theoretical side, it would be useful to analyze whether patent offices should be self-financed or should rather be funded by public money. Another interesting contribution would be to study the extent to which patent fees should be correlated with quality of examination services, as suggested by preliminary evidence in van Pottelsberghe (2010). On the empirical side, microeconomic studies are needed to assess the sensibility to fees of various types of applicants, in particular of small versus large companies. Similarly, firms that make a great use of "strategic" patenting (i.e., that goes beyond the traditional use of protecting against imitation) may also have different response functions and their reaction must be taken into account if fees were to be put in place to control excessive behaviors. A limitation of the existing studies is the systematic elusion of legal costs even though they represent a substantial share of total costs. In this respect, a valuable contribution would be to investigate simultaneously the effect of patent office fees and attorney fees on the patenting behavior of applicants.

As a rule of thumb, the optimal structure of fees is one where (i) application fees are sufficiently high to deter the filing of patents with low marginal value (especially in the current context of highly congested patent offices) and (ii) renewal fees increase more than proportionally with patent age in order to make sure that only the commercially valuable patents are held in force. However, one should not forget that fees are only one policy leverage among others. The quality of the examination process, the coverage of patent rights or the process put in place to challenge a patent are as many dimensions that also impact the good functioning of the patent system. They should be taken into account when policy action is considered.

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A The complex fee schedule of patent systems

Patent systems generally include complex fees schedules, whereby specific fees must be paid according to the examination stage or to the patent characteristics. A simplified fee structure can be summarized as follows.

- Filing or application fees: must be paid at filing and generally lead to the performance of a search report (which summarizes the state of the art and gives an early indication of the patentibility of the invention). At the USPTO it also leads to the examination of the patent;
- Examination fees: must be paid when the applicant requests an examination of his patent, generally after the publication of the search report, on average about 18 months after the first application;
- Grant fees: must be paid when the patent is granted, it includes the publication cost of the granted patent;
- Renewal fees: are paid after the grant of the patent, generally each year. They are paid to keep the patent valid and enforceable. Not paying them induces the patent to fall in the public domain.

Patent fees may actually be more complex: They may include claim-based fees, page-based fees, drawing-based fees, as well as fees for delays amongst many other facets of minor importance. For an insight into the complexity of the fee schedule the reader may consult the USPTO website.

Table 3: Fees in a selected number of patent offices (2010, EUR).

		Up to grant	*Renewal*		
		0 to 4 Y	5 to 10 Y	11 to 20 Y	Total
Austria	AT	830	1,610	10,550	12,160
Belgium	BE	485	690	3,565	4,255
Brazil	BR	417	844	5,522	6,366
Canada	CA	1,147	845	2,500	3,345
China	CN	630	1,260	6,707	7,967
Denmark	DK	1,398	1,398	5,081	6,478
EPO	EP	4,425	6,975	36,811	43,786
Finland	FI	1,890	1,455	6,240	7,695
France	FR	728	710	4,590	5,300
Germany	DE	988	1,280	11,750	13,030
Great Britain	GB	229	667	3,014	3,682
Greece	GR	513	655	5,260	5,915
Hungary	HU	807	2,897	5,308	8,206
India	IN	386	580	2,565	3,145
Ireland	IE	700	988	3,490	4,478
Italy	IT	1,160	870	5,750	6,620
Japan	JP	2,098	3,011	13,255	16,266
Luxembourg	LU	334	491	1,980	2,471
Poland	PL	235	521	2,703	3,224
Portugal	PT	200	825	4,650	5,475
Romania	RO	550	576	2,778	3,354
Russia	RU	1,765	808	4,411	5,219
Singapore	SG	849	633	2,486	3,119
South Africa	ZA	1,374	942	1,684	2,626
Spain	ES	510	696	4,061	4,757
Sweden	SE	658	1,108	4,167	5,275
Switzerland	CH	1,288	830	2,109	2,939
Netherlands	NL	252	1,500	9,500	11,000
USA	US	2,394	2,063	2,854	4,917

Sources: Data collected on patent offices' website. Data for the EPO come from van Pottelsberghe and Mejer (2010) and correspond to a protection in the six most frequently chosen countries of validation after grant of a patent (DE, FR, GB, NL, IT, CH).