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On the price elasticity of demand for patents[1]

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Abstract

This paper investigates whether patent fee policies are a potential factor underlying the boom in patent applications observed in major patent offices. We provide the first panel-based evidence suggesting that fees affect the demand for patents in three major patent offices (EPO, USPTO and JPO), with a price elasticity of about -0.4 (similar to that of the residential demand for oil or water). The laxity of fee policies adopted by patent offices over the past 25 years therefore contributed, to a significant extent, to the rising propensity to patent observed since the mid-nineties. This is especially true at the European Patent Office, which has dramatically decreased its fees since the mid-1990s.

JEL Classification: O34, O30, O31, O38, O57
Keywords: patent cost, patenting fees, price elasticity, patent systems, propensity to patent.

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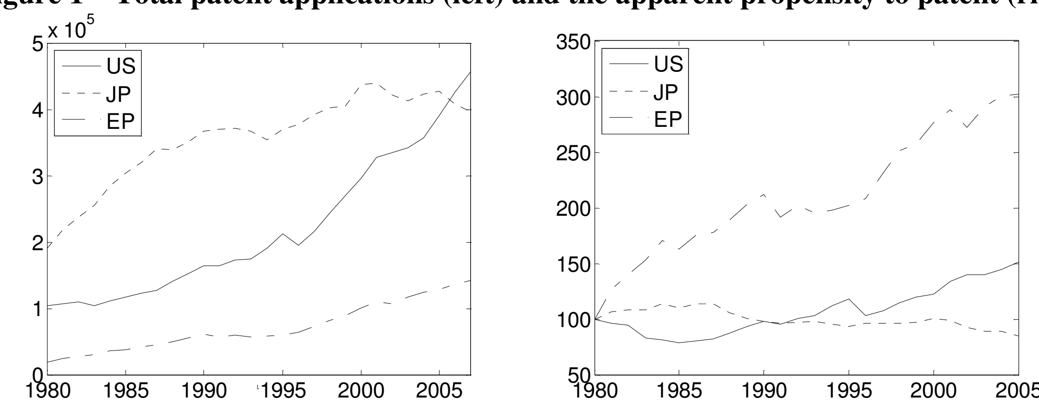
1. Introduction

In 2007 the total number of patent applications filed at the European Patent Office (EPO) again reached a new record of 141,297.[1] The left-hand side of Figure 1 shows that permanent increases in patent filings are not uncommon in patent offices, as illustrated by the spectacular 456,154 and 396,291 applications filed that same year at the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO), respectively. Constant record breaking is, however, not praised by all observers of patent systems. Many concerns are being raised, especially by economists, as witnessed by the recent contributions of Jaffe and Lerner (2004) and Bessen and Meurer (2008) for the US patent system and Guellec and van Pottelsberghe (2007) for the European patent system. The worries are related to the number and quality of incoming patent applications, which induce a longer duration of the substantive examination of patents and generate worrying backlogs, increasing the level of uncertainty on the market.

The right-hand side of Figure 1 suggests that the boom in patent filings in the US and in Europe is due to a higher propensity to patent: the average number of patents filed per R&D expenditure has constantly increased over the past 25 years, and particularly so in Europe. The apparent drop in the Japanese propensity to patent is also due to a change in drafting practices that resulted in a drastic increase in the average number of claims per patent since the late eighties.

Figure 1 – Total patent applications (left) and the apparent propensity to patent (right)



Left panel: JP, US and EP indicate the total number of yearly patent applications from 1980 to 2007 at the JPO, the USPTO and the EPO (euro-direct + pct regional), respectively. Right panel: total patent applications divided by total internal R&D expenditures (1980 = 100). Regarding the European region, the R&D expenditures are computed for each year as the sum of R&D expenditures of the EPC member states. Sources: EPO Controlling Office; USPTO Patent Technology Monitoring Team Report, 2008; JPO's Policy Planning and Research Division; and OECD/MSTI. Own computations.

Kortum and Lerner (1999) argued that the jump in patenting at the USPTO reflects a "burst of innovation" fostered by a shift towards more applied activities. A more nuanced picture is provided by Guellec and van Pottelsberghe (2007). According to the authors, several factors may explain the surge in patent filings observed since the mid-nineties in major patent offices. First, *new countries* such as China, Brazil and India have gradually entered the world patent system, partly stimulated by the Trade-Related Intellectual Property Rights agreements, the so-called TRIPs. Even though their contribution to international patent filings remains modest in comparison with more developed economies, the trend has started and will continue.

Second, *new actors* came to the fore in the most advanced economies. IP awareness is rising amongst SMEs and the Bayh-Dole act regulation ratified in the US in 1980 (or the like in Europe since the mid-1990s) fostered academic patenting. Third, the emergence of *new fields of research*, such as nanotechnologies and biotechnologies, has opened new patenting domains. The fourth reason – and probably the most important one – is related to the emergence of new *patent strategies*. The use of patents is increasingly shifting from the traditional use of protecting one's own innovations to new types of uses.

Since the seminal paper by Cohen et al. (2000), strategic patenting has received considerable attention by economics and management scholars. Firms nowadays protect their market through a wide range of mechanisms and rely heavily on patents for other complementary strategic reasons. Several of those new uses are well identified. They range from preventing rivals from patenting related inventions (patent blocking) to using patents in "standards-setting" negotiations (patent pooling), preventing suits and keeping one's own freedom to operate, enhancing one's own reputation as a successful innovator or earning licensing revenues. The phenomenon is well documented in the literature and is found to increase companies' propensity to rely on the patent system (e.g. Rivette and Klein, 2000; Hall and Ziedonis, 2001; Guellec et al., 2007; and de Rassenfosse et al., 2008). These new behaviors not only contribute to the current boom in patenting but also drastically reduce the quality of incoming applications. For instance, patent flooding, which consists of claiming numerous minor variations around a given invention, or patent thickets, a set of overlapping patents, are strategies that may ultimately put patent systems at risk.

Several factors made "excessive" patent strategies easy to implement.[2] Amongst them, the laxity of patent offices possibly plays a role. Encaoua et al. (2006) argue that "the boom in patent applications [is concomitant with] a general sentiment of relaxation of patentability requirements […] in certain jurisdictions". The argument is also echoed in Sanyal and Jaffe (2006), who show that the explosion of patenting in the US can partly be attributed to lower examination standards at the USPTO. Inappropriate fee policies may also have helped to push the trend upward: if the patenting process becomes cheaper, one may logically expect a higher demand for patents. This fees mechanism is actually under current review by the President of the European Patent Office, Alison Brimelow. [3]

The question of whether patent fee policies hindered – or contributed to – the current boom in patent filings is an important issue, especially in the current context of growing backlogs at patent offices. Studies on the impact of fees are however scarce, which reflects a generalized lack of interest of policy makers in this facet of patent policy design and a common – but probably wrong – wisdom that fees play a limited role. Only a few studies provide evidence suggesting that patenting behavior partly depends on fees. Focusing on a cross section of several countries in 2003, de Rassenfosse and van Pottelsberghe (2007, 2008) find that priority filing fees at national patent offices seem to have a negative impact on the demand for patents, with a price elasticity of about -0.5. Harhoff et al. (2007, 2008) show that validation fees and renewal fees affect negatively the validation behavior of applicants once their patent has been granted by the EPO.[4] These studies are mainly cross-section studies and, to the best of our knowledge, there is so far no time series evidence on the role of patent fees.

The present paper precisely aims at contributing to this recent stream of research by providing a first in-depth panel data analysis of the impact of patent fees. It first analyses how fees have evolved over time in three major patent offices (the EPO, the JPO and the USPTO). Then it tests whether these fees have contributed to the observed boom in patenting by estimating the price elasticity of demand for patents.

The paper is structured as follows. The next section describes the complex fee structure of patent offices and presents the working assumptions that are used to compute absolute and relative fees for the three patent offices. Section 3 analyses the evolution and growth rates of fees over the past 27 years. In section 4 several estimates of the price elasticity of demand for patents are presented. The last section concludes and puts forward some policy implications.

The main findings are that relative patenting fees (i.e. fee per claim per capita) have actually plummeted over the years, in the three regions. Entry fees and cumulated fees up to the grant at the EPO have declined severely since the mid-1990s, which certainly did not act against the boom in patenting observed in Europe. Worse, it probably contributed to it. The quantitative analysis suggests that the fee elasticity of demand for patents is about -0.4.

2. Methodological approach

The fee structure in patent systems is particularly complex. From the filing of an application to the grant of a patent and its renewal, the assignee has to pay various fees at different points in time. The structure of fees in terms of schedule and scope varies substantially across patent offices, which makes international comparisons complex to implement. For instance, filing fees at the USPTO explicitly include the search and examination, and the whole process up to the grant lasts about 30 months. At the EPO, filing and search fees lead to a search report after 18 months. Then the applicant may withdraw its application or opt for a substantive examination and pay examination fees. The process up to the grant lasts about 5 years on average.[5] In addition firms may choose between various routes to reach a patent office (i.e. direct application, second filings or PCT applications), which affects patenting costs. Fees also vary according to the filing strategy adopted by firms: they may opt for an accelerated search request, send late replies, inflate the number of claims and pages or adopt a low quality drafting style.[6] These peculiarities also influence the total cost of prosecuting a patent before the patent office.[7]

The patenting process can be summarized in four key steps, each being associated with specific fees and a particular timing: filing, search, examination and granting. The first step consists of the filing of a patent, which includes a filing fee and a search fee. When the search for prior art is performed and the search report published (in general 18 months after the priority date), it is followed by the examination fees if a request for substantive examination is filed. Then, if the patent is granted, the assignee must pay granting and publication fees.

Comparing fees across patent offices therefore requires a cumulated approach. In what follows, two fee indicators are computed. The first one, *entry fees*, represents the short-term cost of entering the patenting process. It includes all the fees that must be paid during the first 18 months from the filing date and is generally composed of filing fees and search fees. At the USPTO, the examination is performed for all patents (except if the applicant pays a fee to defer examination) and filing fees actually encompass examination fees. The second indicator corresponds to the *(cumulated) fees up to the grant*. It represents the minimum level of fees to be borne by an applicant in order to have its patent granted, encompassing entry fees, examination and granting fees. Table 1 summarizes the composition of the two indicators for the three patent offices.

Table 1 – Composition of fees indicators

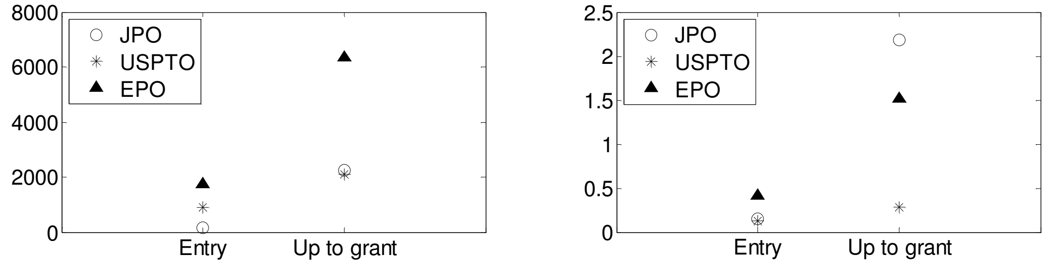
	Entry fees	Total cumulated fees up to the grant
EPO	Filing fees*	Examination fees
	Search fees	Grant fees
JPO	Filing fees	Examination fees*
	Search fees	Grant fees
USPTO	Filing fees*	Grant fees

Notes: At the EPO, the applicant has a maximum of six months from the publication of the search report (i.e. eighteen months after the priority date) to request a substantive examination. At the JPO, an applicant is allowed to wait for three years after the application date to request an examination. * indicates when claim-based fees have to be paid.

Several working assumptions had to be used regarding the mode of interaction with the office and the drafting style; they are described in Appendix A. Amongst these are the number of claims included in a patent. As indicated in Table 1, all patent offices rely on claim-based fees, which may constitute an important share of the total fees.[8] We use the average number of claims per patent in each office to estimate claim-based fees. Fees are expressed in 2000 constant USD PPPs. Detailed data on fees and claims were provided directly by the EPO, the JPO and the USPTO. Data on exchange rates are taken from the International Monetary Fund's World Economic Outlook Database (April 2008).

The computations of entry fees and fees up to the grant are performed for a period of 27 years, in absolute and relative terms. The relative measure follows the methodology put forward by van Pottelsberghe and François (2009). It consists of dividing the absolute fees by the average number of claims included in patent applications and the number of inhabitants in the geographical region covered by the patent system. Since the three offices rely on claim-based fees, and given that the average number of claims varies substantially across the three offices and over time, it is appropriate to compute the fees per claim, the lowest common denominator of an invention. Similarly, a comprehensive international comparison should take into consideration the size of the geographical scope (i.e. a measure of the potential market covered by the patent office). From the point of view of the applicant, a larger market induces a lower fee per market unit. Regarding Europe, the size of the market has been limited to that of five countries (EPC-5): Germany, France, the United Kingdom, the Netherlands and Italy, the most frequently targeted countries (cf. van Pottelsberghe and van Zeebroeck, 2008). Figure 2 displays entry fees and total fees for the year 2007, in absolute and relative terms. Historical data on fees and claims are provided in appendix Table B1. It is important to keep in mind that fee indicators at the EPO are lower bounds of actual cumulated fees, as neither the fees requested by national patent offices for priority filings nor the PCT fees are accounted for. Priority filing fees vary substantially across countries, around a median of €612 according to de Rassenfosse and van Pottelsberghe (2007). It is also important to remind that other costs are not considered in the present analysis, including the costs for drafting and prosecuting patents and translation costs. This type of arms-length costs has been assessed for a given year (e.g. van Pottelsberghe and Mejer, 2008), but it is nearly impossible to provide reliable figures for a period of 27 years in three geographical areas.

Figure 2 – Absolute (left) and relative (right) fees in 2007 in USD PPPs



Notes: Relative fees are fees per claim per million capita. The millions of inhabitants in 2007 in EPC-5, JP and the US are 280, 128 and 302, respectively. The average number of claims is 15, 8 and 24 for the EPO, the JPO and the USPTO, respectively. Cf. appendix Table B1.

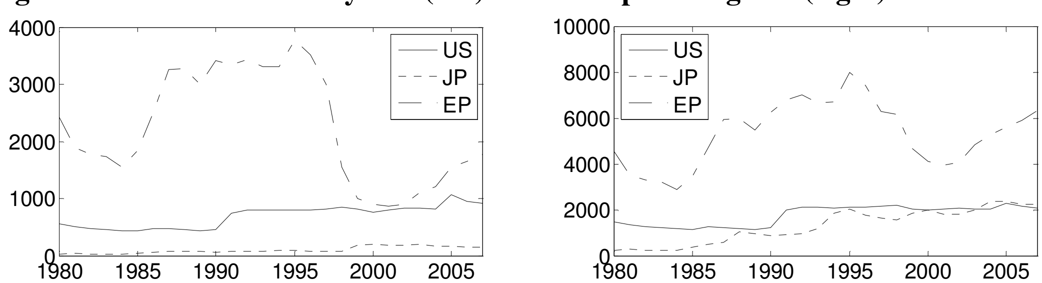
The left-hand side of Figure 2, which presents the level of fees, shows that the EPO is the most expensive office, being two to three times more expensive than the USPTO. Entry fees are particularly low at the JPO, whereas the EPO has particularly high fees up to the grant.[9]

If relative measures are considered (fees per claim per million capita, presented in the right-hand side of Figure 2), the picture looks quite different. In the short term, a European patent is still about three times more expensive than a US or Japanese one. However, as far as total fees are concerned, the combined impact of a low number of claims (which have to be paid at examination request) and a smaller population makes Japan the most expensive market, while the USPTO is by far the cheapest. The next section analyses the evolution of absolute and relative fees since 1980.

3. Descriptive statistics

The evolution of absolute fees is depicted in Figure 3. A strong convergence occurred in entry fees (left panel): while they have been substantially decreasing since the mid-1990s at the EPO, they slightly increased at the JPO and at the USPTO. Europe, however, still exhibits the highest entry fees in absolute terms, and fees at the JPO remain the lowest. Fees up to the grant (right panel) have been increasing in the three offices, in particular at the JPO, with a compound annual growth rate (CAGR) of 8.4% since 1980. Japanese fees up to the grant have gradually caught up with their US counterparts. The EPO had the smallest increase (with a CAGR of 1.3%), but still remains the most expensive office in absolute terms.

Figure 3 – Evolution of entry fees (left) and fees up to the grant (right)

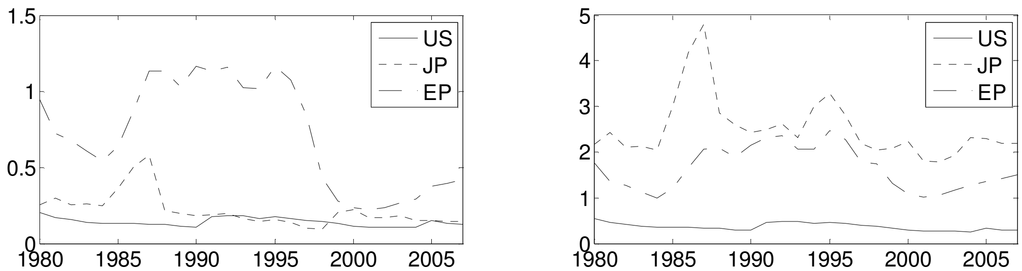


Source: own computation, in constant 2000 US PPPs, 1980-2007. Cf. appendix Table B1.

In an apparent desire to make the patent system more affordable, the EPO substantially decreased its patenting fees at the end of the nineties, especially from 1997 to 1999. In 2000, Gert Kolle, Director for International Legal Affairs at the EPO, commented on the recent changes: "Over the past three years we've reduced patent office costs considerably. Between 1997 and 1999, for instance, the filing fees for a European patent designating all 19 member states have fallen [by approximately 80%][…]. Likewise, the fees paid up to the point of grant during that period have fallen [by approximately 40%][…]. In total, EPO fees have been reduced by around 41%, and I believe we have now reached the point where the potential savings that can be made in patent office costs have been exhausted." [10]

Figure 4 displays the evolution of relative fees (per claim per capita) over the whole period. Relative entry fees have been decreasing over time in the three patent offices, despite a sharp increase from the mid-1980s to the mid-1990s in Europe. The differences in relative entry fees have been drastically reduced over time, but Europe is still the most expensive region in relative terms. Relative fees up to the grant have been consistently decreasing since 1987, in the three patent offices. Differences are, however, still noticeable. Japan remains the place with the most expensive fees up to the grant in relative terms, followed by Europe in an intermediate position and the USA with the cheapest fees per claim per million capita.

Figure 4 – Evolution of relative entry fees (left) and relative fees up to the grant (right)



Note: Fees are expressed in constant 2000 US PPPs, 1980-2007. Relative fees are fees per claim per million capita. Cf. appendix Table B1 for information on fees and the number of claims.

Table 2 presents the compound annual growth rates of both absolute and relative fees in constant national currency, from 1980 to 1995 and from 1995 to 2007. It clearly shows that, since the mid-1990s, the EPO has achieved the sharpest decrease in both entry fees and fees up to the grant, in both absolute and relative terms. A particularly sharp decrease has occurred for EPO relative entry fees, with a drop of about 8% a year between 1995 and 2007 (and about 6% in absolute terms).[11]

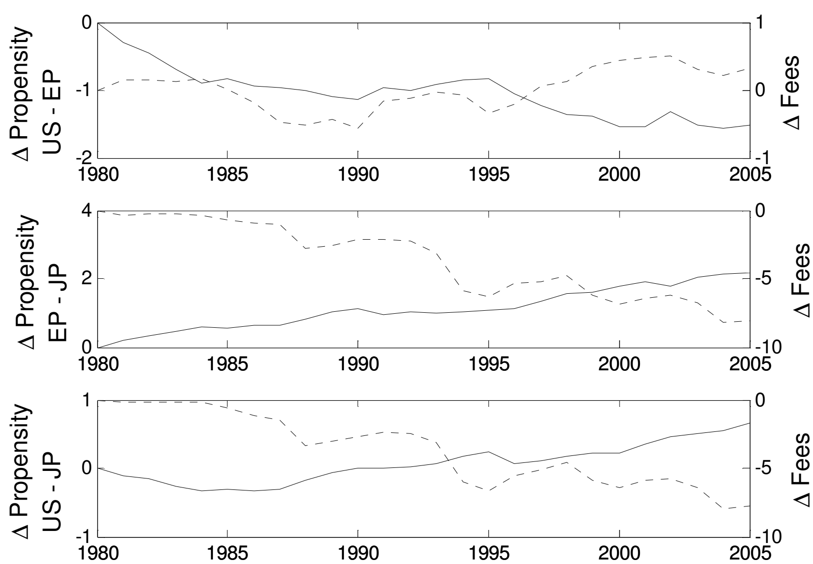
Table 2 – Compound annual growth rate of patenting fees in constant 2000 local currency

	1980–1995			*1995–2007*		
Absolute fees						
	JPO	USPTO	EPO	JPO	USPTO	EPO
Entry	2.04%	2.41%	1.38%	5.46%	1.24%	-6.17%
Up to grant	8.41%	2.38%	2.25%	2.68%	-0.07%	-1.96%
Fees per claim per million capita						
	JPO*	USPTO	EPO	JPO	USPTO	EPO
Entry	-8.47%	-0.97%	-0.20%	1.21%	-2.67%	-8.14%
Up to grant	-2.47%	-0.99%	0.66%	-1.46%	-3.92%	-4.03%

Notes: (*) for JP, the CAGR prior to 1995 has been computed for 7 years, from 1988 to 1995, due to the fact that only one claim per patent was allowed in Japan until 1988 (Kotabe, 1992).

A first glimpse at the potential impact of changes in fees on the behavior of applicants is illustrated in Figure 5. Each panel plots the difference in the propensity to patent (patent applications per R&D expenditure) between the two countries and the difference in the level of fees. The values are normalized to 1 in 1980, so that a difference in, say, relative fees in countries *i* and *j* greater than 0 actually means that fees in country *i* grew faster than fees in country *j*. It clearly appears that a negative trend in the difference in fees is associated with a positive trend in the difference in the propensity to patent, and vice versa. In other words, countries that became more expensive had a lower increase in their propensity to patent. These long-term graphical illustrations suggest that fees may actually affect the behavior of applicants.

Figure 5 – Bilateral differences in the evolutions of the propensity to patent and fees, 1980–2005



Note: Δ Propensity (solid line) is defined as the difference between the propensity to patent in country *i* and the propensity to patent in country *j*, relative to the base year 1980 (=1) [e.g. propensity_eu(t)/propensity_eu(1) - propensity_jp(t)/propensity_jp(1)], reported on the left-hand scale. Δ Fees (dashed line), reported on the right-hand scale, are defined similarly with fees up to the grant.

The next section relies on panel data econometric techniques to approximate the level and significance of the fee elasticity of patents.

4. Empirical analysis

The aim of this section is to estimate the price elasticity of demand for patents. We do so by approximating the parameters of a traditional patent production function of the form:

$$P^* = \delta R^{\beta 1} F^{\beta 2}, \qquad (1)$$

where P^* is the equilibrium level of the demand for patents, δ is the propensity to patent, R is the total R&D expenditures, capturing both the innovation capability of a country and its market attractiveness, and F is the fees up to the grant to be borne by the applicants.[12] β_1 is the elasticity of patents with respect to R&D expenditures and β_2 represents the price elasticity of demand for patents, which is expected to be negative.

The nature of the data is analyzed as a preliminary step, and particularly whether the variables are stationary and co-integrated. A large literature on unit roots in panel data has recently emerged and several statistical tests have been proposed. We implement three tests proposed by Levin, Li and Chu (2002), Im, Pesaran and Shin (2003) and Maddala and Wu (1999), which all assume independence across units. It appears that none of the tests allow us to reject the null hypothesis of a homogeneous autoregressive root (see Table C1 in Appendix C); all the series are therefore non-stationary. We then test for co-integration between the variables using the four panel data tests developed by Westerlund (2007). The null hypothesis of no co-integration is always rejected, indicating that the panel is co-integrated as a whole (see Table C2 in Appendix C). The result bears an interesting insight into the R&D-patent relationship, as it suggests that there is a long-run equilibrium level between the number of patents and R&D efforts, taking into account other determinants of patent filings such as the level of patenting fees.

In order to approximate the elasticities, two econometric models are used: a partial adjustment model and an error correction model. While the former is intuitive to differentiate between short- and long-run elasticities, the latter takes advantage of the co-integration between variables.

Partial adjustment model

The logarithmic transformation of the patent production function (1) produces the following additive model:

$$\ln P_{it}^* = \delta_i + \beta_1 \ln R_{it} + \beta_2 \ln F_{it} + \varepsilon_{it} . \qquad (2)$$

R_{it} and F_{it} are both expressed in constant USD PPP of 2000. There are three countries ($i \in [1,3]$) and twenty-six years ($t \in [1,26]$). δ_i captures the constant propensity to patent for country i (assimilated to the fixed effect in the regressions) and ε_{it} is the error term.

Equation (2) implicitly assumes that the demand for patents immediately adjusts to its long-run equilibrium level P^*. There are many reasons to challenge this assumption and to assume that adjustment to any new equilibrium level occurs over several periods. First, the filing of patents is subject to a learning process: the current level of patents is likely to affect next year patenting activity. Second, the sequential and cumulative aspects of research and development projects imply that an invention patented in a given year may be improved and yield further patentable improvements in the subsequent years.[13] Dynamic models can easily be recovered from equation (2) if one introduces a dynamic partial adjustment process of the form (see e.g. Nerlove, 1958):

$$\frac{P_{it}}{P_{i,t-1}} = \left(\frac{P_{it}^*}{P_{i,t-1}}\right)^{\lambda}, \; 0 < \lambda < 1,$$

where λ measures the rate of adjustment (the higher the lambda, the faster the adjustment mechanism). Taking the expression to the log and substituting for $\ln P^*$ into equation (2), we obtain the following partial adjustment equation:

$$\ln P_{it} = \delta_i^s + (1-\lambda)\ln P_{i,t-1} + \beta_1^s \ln R_{it} + \beta_2^s \ln F_{it} + \upsilon_{it}\,, \qquad (3)$$

where β^s/λ equals β in equation (2) and represents the long-run elasticity, while β^s represents the short-term elasticity. The inclusion of the lagged dependent variable in the model may result in biased estimates. Therefore, three methods are used to correct for this source of bias. First, we rely on instrumental variables for the lagged number of patents. The instruments are the total number of inhabitants and the GDP per capita (capturing both the size and the level of technological development of the region). A second and alternative methodology consists of running a Kiviet-type regression (Kiviet, 1995), that directly removes the bias for the lagged estimator. The estimation method is based on Bruno (2005), which is particularly suited for a small number of individuals. The Arellano-Bond estimator is the third method used to instrument for $P_{i,t-1}$.

Error correction model

As the variables included in equation (2) are co-integrated, an error correction model (ECM) can also be used to leverage the dynamic structure of the correction term. The ECM allows combining the long-run co-integration relationship and the short run effect. The error correction term is the residual from the estimated long-run relationship – i.e. the difference between the observed and the estimated demand for patents in levels:

$$e_{it} = \ln P_{it}^* - \hat{\delta}_i - \hat{\beta}_1 \ln R_{it} - \hat{\beta}_2 \ln F_{it}\,.$$

The correction term is then used as an adjustment process to capture long-run dynamics. The ECM is defined as the first difference of equation (2) plus the error correction term:

$$\Delta \ln P_{it}^* = c_i + \alpha_1 \Delta \ln R_{it} + \alpha_2 \Delta \ln F_{it} - (\alpha_3 \ln P_{i,t-1}^* - \gamma_i - \alpha_4 \ln R_{i,t-1} - \alpha_5 \ln F_{i,t-1}) + \eta_{it}\,, \qquad (4)$$

where α_3 may range from no adjustment (0) to full adjustment (-1). Long-run effects for, say, fees are recovered by dividing α_5 by the adjustment coefficient α_3 (for a discussion, see Alogoskoufis and Smith, 1991). Table 3 presents the estimated parameters of both the partial adjustment model and error correction model. The first model is estimated with three econometric methods. The econometric method used for the ECM is a Prais-Winsten regression, which corrects for the potential contemporaneous correlation of residuals. Equation 4 is estimated for both fees up to the grant and entry fees.

Table 3 – Estimates of the parameters of the patent production function

Model:	Partial Adjustment			ECM	
Dep. Var.:	ln_pat	ln_pat	Δ ln_pat	Δ ln_pat	Δ ln_pat
Fees	Up to grant	Up to grant	Up to grant	Up to grant	Entry
Est. method	LSVD C.B.	IFGLS	GMM	Prais-Winsten	Prais-Winsten
	A	B	C	D	E
ln_pat (t-1)	0.808 ***	0.860 ***		-0.153 ***	-0.110 ***
	(9.87)	*(19.76)*		*(3.59)*	*(2.60)*
Δ ln_pat (t-1)			0.634 ***		
			(10.30)		
ln_rd	0.285 *	0.274 ***			
	(2.56)	*(3.36)*			
Δ ln_rd			0.274 ***	0.547 *	0.522 *
			(2.77)	*(2.44)*	*(2.27)*
ln_rd (t-1)				0.287 ***	0.146 *
				(3.26)	*(2.05)*
ln_fees ¤	-0.06 ***	-0.081 ***			
	(2.42)	*(4.51)*			
Δ ln_fees ¤			-0.048 *	-0.120 ***	-0.049 *
			(2.46)	*(3.29)*	*(1.71)*
ln_fees (t-1)				-0.073 ***	-0.032 *
				(3.63)	*(2.12)*
Adj. R^2	0.90	0.98	0.81	0.21	0.06
Observations	75	75	72	75	75

The dependent variable is the number of patents applied for at the JPO, the USPTO or the EPO, in level (ln_pat) or in first difference (Δ ln_pat). The econometric methods are for column A: iterated FGLS with capita and GDP per capita used as instrumental variables for the lagged number of patents, and correcting for autocorrelation of residuals and contemporaneous panel correlation; column B: least square dummy variable correcting for bias (LSDV C.B.) with bootstrapped standard errors (Bruno, 2005); column C: Arellano-Bond GMM with one lag of the dependent variable; columns D and E: Prais-Winsten regression, correcting for contemporaneous correlation of residuals. ¤ In column E fees denote *entry fees* instead of fees *up to the grant*. ***, ** and * indicate significance at the 1, 5 and 10 percent probability threshold, respectively.

Estimations of the parameters of the partial adjustment model are presented in columns A to C, and estimations of the error correction model are presented in columns D and E. The fees used are cumulated fees up to the grant, except in the last column, where the elasticity of entry fees is reported. The estimated price elasticity is always negative and significant and suggests short-term elasticities of fees up to the grant that vary between -0.05 and -0.12. Long-run elasticities must be computed from the estimated parameters and multipliers; they are displayed in Table 4. They range between -0.13 to -0.58, with an average of about -0.4 for cumulated fees up to the grant. The results are very much in line with the price elasticities estimated by de Rassenfosse and van Pottelsberghe (2007, 2008) with large cross sections of countries. They report elasticities that vary between -0.45 and -0.56, which compare fairly well with the present long-run estimates. They confirm that patents are a relatively inelastic good. The long-term patent elasticity of R&D expenditures is about 1.5. Yet, one has to be cautious not the interpret the parameter at face value since the variable capture the potential of a region both in terms of research output and market attractiveness. If entry fees are taken into account, column E of Table 4 shows that the elasticity falls to -0.29, slightly lower than the estimated elasticity of fees up to grant.

Table 4 – Long-term elasticities

	A		B		C		D		Mean (A to D)	E	
R&D	1.48	***	1.95	***	0.75	***	1.87	***	1.51	1.33	***
	(0.38)		*(0.27)*		*(0.22)*		*(0.22)*			*(0.27)*	
Fees	-0.31	*	-0.58	***	-0.13	**	-0.48	***	-0.38	-0.29	***
	(-0.16)		*(-0.19)*		*(-0.06)*		*(-0.09)*			*(-0.11)*	

Elasticities estimated from the regression results of Table 3. Standard errors are in parenthesis.

5. Concluding remarks

The main objective of this paper was to assess whether fees could be one factor underlying the boom in patent applications observed over the past two decades in three major patent offices, in Europe (EPO), the USA (USPTO) and Japan (JPO). In order to perform a quantitative analysis based on panel data, entry fees and fees up to the grant have been computed for a period ranging from 1980 to 2007. This unique dataset clearly shows that the EPO has operated the sharpest decrease in patent fees since the mid-1990s, in both absolute and relative terms (fees per claim per capita), and for both entry fees and fees up to grant. The USPTO has maintained nearly stable absolute fees since 1995, but has experienced a slight drop in relative fees. Despite this convergence, the EPO still has fees that are two to three times higher than those of the USPTO in 2007.

The second contribution to the literature is to test empirically the intuition that fees may affect the filing behavior of applicants. This is performed through an in-depth quantitative analysis aiming at evaluating the amplitude and significance of the price elasticity of demand for patents. The panel data analysis of 25 years of patent filings at the three offices underlines the prime role of research activities, and a significant price elasticity of demand for patents of about -0.4, which is in line with the few existing estimates based on cross-sectional analyses. This price elasticity is in a similar range than the estimated price elasticities of demand for residential electricity and natural gas in the US or of the residential water demand (Bernstein and Griffin, 2006; Dalhuisen et al., 2003). It is tempting to conclude that patents seem to be to R&D what energy and water are to humankind: a basic necessity.

These results confirm that fees can actually be taken as a factor influencing the propensity to patent, and hence can be considered as an effective policy leverage by policy makers. The sharp drop in fees orchestrated by the EPO, in both absolute and relative terms, and the stable, though very inexpensive, fee policy of the USPTO, combined with the negative and significant price elasticity of demand for patents, certainly did contribute to the observed boom in patent filings. A clear solution to the current backlog crisis would therefore be to adopt a more stringent fee policy, which is precisely what the current President of the European Patent Office aims at achieving. Higher fees would counterbalance the downward trend in fees that was implemented in the mid-1990s, thereby contributing to reduce the upward trend in the propensity to patent. As the fee elasticity is much smaller than unity such a policy would further contribute to reinforce the funding model of the EPO.

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A. Working assumptions

Each patent office has its own fee structure, which makes international comparisons a difficult exercise. The assumptions made for the empirical analysis seek to make the results reasonably comparable. The present appendix provides the list of working assumptions that were made when measuring absolute and relative fees, for both entry fees and fees up to the grant.

- The applicant is assumed to be a large entity (SMEs have reduced fees in the USA and Japan, but large firms still account for the most important share of applications);
- No late payments, paper filing (as opposed to electronic filings, which are slightly less expensive);
- A change in price *during* the year is assumed to be effective the next year if it was implemented after June 30. If it was implemented on or before June 30, it is assumed effective at the beginning of the year.
- Modification in the timing of fees has been taken into account when the information was provided by the patent office. Otherwise, it is assumed not to have changed over time. At the EPO, designation fees were included in entry fees before 1998, and in total cumulated fees up to the grant for the subsequent years.

Other country-specific assumptions are:

1. USPTO-related assumptions:
    - Fees are missing for the years 1980, 1981 and 1982. They were assumed to be equal to the fees of 1983;
    - Three independent claims have been considered.

2. EPO-related assumptions:
    - Euro-direct fees have been considered (the PCT route generally induces slightly higher fees);
    - Use of European Search Report since 2005;
    - Five countries were taken into consideration to compute the relative fees: Germany, France, the United Kingdom, Italy and the Netherlands.
    - Exchange rates and inflation for EPC countries are based on German macroeconomic data and provided by Eurostat.

B. Historic data on patenting fees

Table B1 displays the cumulated fees (entry fees and fees up to the grant) in current national currency for a representative patent, as well as the average number of claims included in the patents filed in each patent office.

*** Insert Table B1 around here ***

C. Panel unit roots and co-integration tests

We implement three panel unit root tests proposed by Levin, Li and Chu (2002), Im, Pesaran and Shin (2003) and Maddala and Wu (1999).They are denoted LLC, IPS and MW, respectively. The disturbances of autoregressive models are assume to have a zero mean, finite variance and might exhibit autocorrelation. In each case, the null hypothesis is that of a unit root for all individuals. LLC is performed under the restrictive alternative of an homogeneous autoregressive root. IPS extends LLC in that the alternative allows both for heterogeneous roots and for heterogeneous presence of a unit root (i.e. the alternative is that there might be a unit root for some individuals, but not for all). The test statistic is based on the ADF statistics averaged across the individuals. Finally, MW is closely related to IPS but relies on combining the level of p-values of the independent unit root tests. Table C1 summarizes the various results.[14]

Table C1 – Panel unit root tests

	P*		***R***		***F***	
	Value	p-value	Value	p-value	Value	p-value
LLC	0.92	0.82	0.03	0.51	0.69	0.75
IPS	3.09	0.99	2.23	0.99	0.81	0.79
MW	9.25	0.16	0.89	0.99	3.58	0.73

P, R and F stands for patents, R&D expenses and Fees, respectively. Individual effects included. LLC: corrected t-stat reported. IPS: W_{tbar} reported. MW: Fisher statistic based on individual ADF statistics and their associated p-value pooled test statistic. A Matlab code is available from C. Hurlin.

None of the tests leads to a rejection of the null hypothesis of a homogeneous autoregressive root. Then, a potential co-integration relationship between the variables is tested using the four panel-data tests put forward by Westerlund (2007). Two tests (labelled *G*) are performed under the alternative that the panel is co-integrated as a whole, while the two other tests (labelled *P*) are designed under the alternative that there is at least one individual that is co-integrated. In all cases, the null is of no co-integration. The results are presented in the Table C2.

Table C2 – Panel co-integration tests

	Value	p-value[a]	p-value[b]
G_τ	-3.48	0.00	0.05
G_α	-14.22	0.08	0.01
P_τ	-5.86	0.00	0.01
P_α	-12.92	0.02	0.02

The tests are implemented with a constant. The lags in the error correction equation are chosen according to the Akaike information criterion. (a) p-values under the normal distribution. (b) p-values based on the bootstrapped distribution (400 runs). τ and α indicate different test statistics. Cf. Persyn and Westerlund (2008) for further methodological details.

The null hypothesis of no co-integration is rejected, and the *G* values further indicate that the panel is co-integrated as a whole.

[1] This figure does not include the PCT-International filings for which the EPO must 'only' provide a search report. Had these filing been taken into account, the total number of applications would have been higher than 200,000.

[2] The term “excessive” is used here to qualify behaviors that consist in applying for a patent for a very low quality invention, or a small inventive step. This may occur through patent thicket strategies or through a higher propensity to patent “nearly obvious” inventions. It also reflects a strategy that consists in filing several dozen of similar patents to increase the probability of a grant.

[3] “Ms Brimelow says one answer may be higher fees. "*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.*"” Financial Times, November 23, 2007.

[4] Additional insight into the role of fees is provided by Archontopoulos et al. (2007) and van Zeebroeck et al. (2008), who show that the change in claim-based fees by the USPTO in December 2004 has reached its objective of reducing the average number of claims in patent applications, although with a low elasticity (of about -0.20).

[5] According to Harhoff and Wagner (2005), the process up to the grant lasts about 4 years on average. van Zeebroeck (2008) shows that the grant lag has been increasing over time and is nowadays around 5 years.

[6] See appendix A for the current fee structure at the EPO and Stevnsborg and van Pottelsberghe (2007) for an in-depth description of the routes of patenting and a detailed typology of filing strategies adopted by firms nowadays.

[7] Cf. van Pottelsberghe and François (2009) and van Pottelsberghe and Mejer (2008) for an in-depth comparison of the fee structure at the USPTO, the JPO and the EPO.

[8] Claims are the substance of a patent, the codified description of the invention that constitutes the scope of protection in case of a grant. The fees are thus computed for the “representative” patent in each of the three offices.

[9] These cumulated fees for the EPO do not include the translation costs and the validation fees that must be paid in each desired national patent office once the patent is granted by the EPO. If these costs were taken into account, an EPO patent would be 5 to 10 times more expensive than a USPTO patent, as shown by van Pottelsberghe and François (2009).

[10] Interview with Richard Poynder for Thomson Scientific: “Discussion of European Patent System”, May 2000, http://scientific.thomson.com/free/ipmatters/euroiss/8202774/. Note that the sharp decrease in short-term fees is exacerbated by the reallocation of designation fees from “entry fees” to “fees up to the grant” in 1998.

[11] It is important to keep in mind that the average growth rate of relative fees in Europe is an upper bound estimate, because we have assumed that the market size was “only” related to the 5 countries in which patents are validated after the grant by the EPO. However, it could be argued that the whole geographical area covered by the EPO should be taken into account, i.e. currently about 500 million inhabitants. Should this be the case, and given the fast increase in the number of EPO Member States (from 11 in the early eighties to 34 nowadays – that is more than one additional country every year), one would have observed a waterfall shape in the relative fees at the EPO over the past twenty years, which reinforces the idea that relative fees severely plummeted in Europe.

[12] The focus here is more on the elasticity of the fees up to the grant than on entry fees. This assumption suggests that applicants are influenced more by the cumulated fees of the process they start. It could, however, be argued that some applicants may be interested only in short-term protection (i.e. a “patent pending” protection). Additional estimates of the elasticity of entry fees are therefore also reported.

[13] It can be argued that the R&D expenditure variable should be lagged so as to take into account the potential delay between the research activities and the occurrence of a patent. However, the largest share of R&D is actually composed of development activities (already patented inventions that are under prototype and market testing), which are much more contemporaneous to patent applications. In any case, the dynamic specification allows for a “delayed” impact of R&D expenditures over time.

[14] Note that the three tests all assume independence between individuals. Hurlin and Mignon (2006) provide an excellent overview of unit root tests for panel data.