

Filing strategies and patent value ^μ *

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FIRST DRAFT – COMMENTS WELCOME

Abstract

Patenting strategies are suspected to be a significant driver of the surge in the number and size of patent applications filed around the world, increasing workloads and backlogs at patent offices and resulting in a higher legal uncertainty on the markets. This paper proposes some measures to identify different dimensions of strategic filing behaviours (the filing route to reach the EPO and the style of drafting: oversized claims, drafting by assembly, divisional filings) and shows how they have evolved at the EPO over the past two decades. The main result of this paper is to show that these strategies are consistently and positively associated with patent value and may hence be used as a new class of determinants. The empirical implementation relies on a unique dataset made of about 250,000 EPO patent grants and uses 6 different indicators of patent value as dependent variables, offering as a complementary result a large-scale sensitivity test of most established determinants of patent value to the indicator and the sample used in the estimates, all subject to a comprehensive review of the literature. The results of this exercise confirm some of the established determinants of value in their role, but also spot strong dependencies of the results to the dependent variables and sampling methodologies, prescribing much care in generalizing such results.

Keywords: Patent systems, Patent quality, Patent value, Patenting strategies

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1. Introduction

Patent systems worldwide have been characterized by two common trends: an unprecedented boom in the number of patent applications and a parallel increase in their size. The growing number of patent filings is due to many factors (e.g., the globalization of markets, new generic technologies, the emergence of new countries like China, and the arrival of new actors like universities). One of these factors, strategic patenting, is believed to substantially affect patent systems because it both increases the number of patent applications and reduces their average quality (firms apply for more patents for a given invention or have a higher propensity to patent inventions of a lower quality). The direct consequences of these evolutions is a sharp increase in the workloads – and hence backlogs – for patent offices, leaving much uncertainty on the markets for technology.¹ An indirect consequence has been the burgeoning economic and managerial literature on patent value.

Over the past 20 years research scholars, led by Narin et al. (1987), Trajtenberg (1990), Scherer and Harhoff (2000) and Hall et al. (2001), have developed various models essentially aiming at finding an appropriate weighting scheme to count patents, or at identifying the most promising patents within the ocean of codified knowledge published each year by major patent offices. The early surveys provided by Reitzig (2004a) and Sapsalis and van Pottelsberghe (2007) show that two broad types of variables have been used to predict the potential value or the quality of patents. The first one is based on various characteristics of patents (e.g. the number of forward citations, the occurrence of an opposition, the number of backward patent citations or citations to the scientific literature), and the second one is related to the applicants' profile and ownership structure (e.g. the type and size of the firm, cross-border ownership, co-application). The present paper builds on the existing literature by adding a new class of potential determinants of patent value: the filing strategies adopted by firms.

The main objective of the present paper is precisely to investigate whether the different dimensions of a patent filing strategy affect the value or importance of patents.² Several dimensions of filing strategies have been described by Harhoff (2006) and Stevnsborg and van Pottelsberghe (2007). They range from the form and quality of the drafted document (the number of claims filed or abandoned in the course of the examination), the construction of patents by assembly or disassembly, and the filing of divisional applications, to the route chosen to reach the EPO (via the PCT process or not) and the request for accelerated search. Harhoff has show that some of these strategies have been increasingly used over the past two decades and the typology provided by Stevnsborg and van Pottelsberghe explicitly suggests that some strategies essentially aim at slowing down the examination process. This paper investigates whether they may as well be used as factors indicative of a higher or smaller value of patents.

To address this research question empirically we rely on a unique dataset containing a large number of variables on all granted patents that were filed before the EPO between 1990 and 1995 (about 250,000 patents). This unique 'size' and 'breadth' of the dataset allows to provide a second contribution to the literature, which is to test whether and to what extent the existing results have been affected by sampling methodologies or by the chosen indicator of patent value.

¹ The determinants and consequences of the boom in patent applications has been analysed by Kortum and Lerner (1999) and Jaffe and Lerner (2004) for the US patent system and by Guellec and van Pottelsberghe (2007) for the European patent system. The sharp increase in voluminosity (in terms of the average number of pages and/or claims included in a patent) is thoroughly documented by van Zeebroeck et al. (2006a) and Archontopoulos et al. (2007). van Pottelsberghe and van Zeebroeck (2007) provide evidence suggesting that the average value of the patents granted by the EPO between 1985 and 1995 has constantly decreased. Bessen and Meurer (2005) illustrate the intensifying number of patent litigations in the US.

² Throughout the remainder of this paper the various measures of patent value used as dependent variables will be referred to as 'patent value indicators', though they are only used as proxies for the unobserved monetary value.

In terms of dependent variables, five different indicators of patent value, based on patent data and widely used in the literature, are used in the present paper as well: forward citations, European family size, triadic, renewals, and opposition incidences.³ As these classical indicators capture different dimensions of patent value, a single composite index developed by van Zeebroeck (2007) is also used. The different features of filing strategies and the more classical determinants (patent characteristics and type of ownership) are to be tested against each of the five established measures and the composite index. The size of the dataset allows testing for the stability of the estimated parameters to the geographical origin of the patents and their technological area.

The paper is organised as follows. Section 2 introduces the different dimensions of patent filing strategies, some related measures and their evolution. Section 3 summarizes a comprehensive review of the empirical literature on patent value (covering 66 distinct empirical works), and familiarizes the reader with established indicators and determinants. Section 4 presents the empirical implementation. The results are discussed in section 5 and section 6 concludes.

The results of this paper first show that most dimensions of patent filing strategies are positively, significantly and consistently associated with more valuable or more important patents. This is particularly the case with the number of claims and priorities, with the choice of the PCT route and divisional applications. This suggests that when a knowledge asset is more valuable, a patentee tends to recourse to more aggressive filing strategies. The results further confirm the positive impact of some of the most popular determinants (such as the number of claims and inventors and the PCT option), but also points out strong sensitivities to the sampling methodology (country- or industry-wise) and the patent value indicator used as dependent variable.

2. Filing strategies

As patent systems evolve and become increasingly popular, new strategies emerge in terms of managing patenting processes and maximizing the legal protection of inventions. Harhoff (2006) has developed the notion of patent constructionism,⁴ illustrating how firms play with patents as with Lego's to build patent portfolios. Stevnsborg and van Pottelsberghe (2007) scrutinize the numerous options patentees are offered along the patenting process at the EPO and identify strategic behaviours clearly aiming at exploiting every procedural possibility offered by the system to delay the granting process or to obtain the broadest possible scope of protection.

The costs and additional red tape associated with most of these strategies suggest at first sight that the underlying inventions must be worth these burdens and hence that the resulting patents should be of higher value. The main objective of this paper is precisely to address this question and by so doing to contribute to the literature on the determinants of patent value. This objective requires the construction of several variables to identify the various strategies, which are described in Table 1. They are essentially twofold: some of them relate to the path followed to reach the EPO and get a European patent granted, the others pertain to the way the application has been drafted. The former group of strategies has already been accounted for in different papers, but the second – to the best of our knowledge – has never been tested as determinants of value so far.

³ van Zeebroeck (2007) provides a detailed and comprehensive analysis of those indicators and their evolution over time for European patents.

⁴ Harhoff (2006) defines patent constructionism as the “strategies and tactics used by patent applicants to construct patent portfolios by constructing overlapping, multiple filings with high similarity from smaller building blocks (claims, first filings) or by recombination of smaller building blocks (claims, first filings).”

Filing routes

The Patent Cooperation Treaty (PCT) multiplied the number of potential routes toward the EPO⁵ which are now entirely part of the strategic choices that any patent applicant needs to make before reaching the EPO. Since the Paris Convention (1883), applicants have one year from the date of their first (priority) filing to extend their patent application to any other country in the world. Therefore, until recently, most patentees used to file an application at their domestic patent office and transfer it to other offices where they sought protection within 12 months. Until the mid-eighties, this was the case for more than 90% of all applications filed to the European Patent Office (EPO). Since then, the PCT – entering into force in 1978 – has offered patent applicants a new option to delay the international extension of their priority filings from 12 to 30 months while more easily and efficiently managing the transfer of their filings to patent offices worldwide.

These benefits have convinced many applicants to opt for the PCT process, so that about 53% of applications filed to the EPO in 2005 were transferred to the EPO under the PCT.⁶ Over the period considered in the present analysis (1990-1995), about 30% of the granted patents were filed via the PCT option. Because of these benefits, the PCT procedure may carry applications that are clearly aimed at being widely extended worldwide and may hence be associated with more value. But it may also concern applications that were filed very early in the innovation process, at a time when the invention's market potential was still unclear (van Zeebroeck et al., 2006a). In such a case, the patentee may have preferred to delay by an extra 18 months the time when a final decision as to whether the application is worth being extended abroad or not would have to be made, and the application itself may hence be of much or of very little value, if any. Therefore, the overall association between the PCT option and patent value is a priori unclear.

Whereas the PCT route has as main effect a substantial delay in the patenting process, at the time the application is filed at the EPO the patentee is allowed to file a request for accelerated search and/or examination in order for the file to be processed more rapidly. Table 1 shows that accelerated searches (*ACCSRC*) are requested in as low as about 2% of the cases. One particular strategy associated with this procedural option consists in filing a Euro-Direct application (i.e. non-PCT) with an accelerated search request, so that a preliminary opinion on the patentability of the invention may be obtained very quickly and a decision to pursue the granting process may be taken within a short period of time when applicants are unsure about their chances to get a patent grant. Accelerated searches and examinations may also be used by patentees who are very confident about the patentability of their invention and just want their patent to be granted as fast as possible. As a consequence, the association between accelerated search requests and patent value is also a priori ambiguous.

Drafting styles

The drafting style of patent applications, instrumentalized by some applicants in an attempt to reinforce the legal strength of their patents, to circumvent the disclosure requirement, or to create smoke screens or uncertainty in a specific area, is made of three main dimensions.

One, van Zeebroeck et al. (2006a) have shown that the severe inflation in the size of patent applications at the EPO was notably due to a progressive harmonization of drafting styles toward American drafting modes, themselves largely influenced by legal changes in the US patent system. The authors observed in addition that the number of claims in an application is strongly influenced by the technology at stake (biotechnologies and computers being associated with the largest numbers). The literature on patent value has frequently used the number of claims as a proxy for the

⁵ See Stevnsborg and van Pottelsberghe (2007) for a comprehensive overview of these routes.

⁶ EPO Annual Report, 2005.

breadth or complexity of patents (Tong and Frame, 1994), suggesting – and empirically demonstrating – a positive correlation with patent value. However, raw counts of claims may be biased by technology specific practices and their evolution over time. Therefore, the number of claims as such does not provide a fair indication on the strategic behaviour of a patentee in drafting an application. Rather, the deviation of the number of claims a given application contains as compared with the average number of claims contained in applications from the same sector and filed in the same year provides a very interesting measure of the relative oversize of an application, potentially denoting a strategic behaviour. This deviation is computed within the ‘*CLMDEV*’ variable according to Equation 1.

$$CLMDEV_i = \frac{C_i}{\frac{1}{n(S_i, Y_i)} \sum_{j=1}^{n(S_i, Y_i)} C_j} \quad (1)$$

In this equation, $CLMDEV_i$ is the relative deviation in number of claims of application i , C_i is the number of claims contained in application i , and $n(S_i, Y_i)$ is the number of applications filed in the same technology joint cluster (S_i) and year (Y_i) as application i , with $i \in \{1, \dots, n(S_i, Y_i)\}$. Table 1 shows that the average number of claims as a percentage of the same year country average is about 99%, that is the deviation is on average very small or even close to 0. However, extreme values ranging from 6% to 2867% suggest the presence of large outliers and a high level of skewness in the distribution. To deal with this severe skewness, the variable will be taken in logarithm within the estimation equations. Given the cost incurred by excess claims (the EPO charges additional fees for claims in excess of 10) and because excess claims may represent more robust or larger patents (including more fall-back positions or encapsulating a larger scope of protection), this variable is expected to be positively associated with patent value.

Table 1 - Summary Statistics of Filing Strategies Variables

| Variable | Obs. | Mean | St. Dev. | Min | Max |
|-----------------------------------|-------------|-------------|-----------------|------------|------------|
| PCT | 248,856 | 0.29 | 0.45 | 0.00 | 1.00 |
| ACCSRC | 248,856 | 0.02 | 0.13 | 0.00 | 1.00 |
| CLMDEV | 248,848 | 0.99 | 0.73 | 0.06 | 28.67 |
| CLMLS | 245,194 | 1.63 | 6.28 | -152.00 | 350.00 |
| CLMLS (as % of # claims at grant) | 245,194 | 0.29 | 1.05 | -1.00 | 116.50 |
| PRIOR | 248,856 | 1.20 | 0.84 | 0.00 | 49.00 |
| EQUIV | 248,856 | 0.13 | 0.53 | 0.00 | 24.00 |
| HASDIV | 248,856 | 0.04 | 0.20 | 0.00 | 1.00 |
| ISDIV | 248,856 | 0.03 | 0.16 | 0.00 | 1.00 |

Source: Own calculations based on EPO data – Granted patents filed 1990-1995

As a complement, the share of claims abandoned in the course of the examination proceedings (*CLMLS*) may be a good indicator of potentially abusive drafting strategies. It should be recalled here that the examination process often takes the form of an interactive process between the examiner and the patent agent, which ends up in a final set of claims that would be allowed for grant by the examiner. In this respect, the number or share of claims abandoned is informative of the scope of protection that has been refused by the examiner (Stevnsborg and van Pottelsberghe, 2007), and is therefore expected to have a detrimental effect on patent value. Here again, whereas the average number of claims lost is about 1.6, extreme cases range between 152 claims added to the application and 350 claims abandoned.

Two, the progressive shift from single patent strategies to patent portfolio strategies has led patentees to no longer rely on a single patent to protect an invention but rather to build a set of intellectual property rights. The size and strength of the patent portfolio therefore matters more than the quality of each individual patent. This change in reliance on and use of the patent system contributed to the well known surge in patent filings around the world (Kortum and Lerner, 1999) and has given rise to new schemes in constructing patent filings (Harhoff, 2006). In particular, applicants increasingly split national priority filings into a set of applications with a common root that they file or extend to the EPO (cf. Harhoff's Type I construction), and conversely merge several national priority filings to form one single EPO application (cf. Harhoff's Type III construction).⁷ The average number of EP equivalents (EP filings having at least one priority in common) or *EQUIV* is about 0.13 but ranging from 0 (no EP equivalents) to 24 (extreme case of Type I construction), and the average number of priorities per EPO application (*PRIO*) is just over 1 (about 1.2) but actually ranges from 0 (EPO first filings) to 49 (extreme case of Type III construction).⁸ At first sight, the drafting and procedural costs associated with such strategies suggest that only higher value inventions would justify them, and the corresponding variables should be associated with more valuable patents as a result. However, should a given scope of protection be split into different filings, one could hardly foresee the way the value of the underlying invention will spread across these filings. Assuming that most value could remain concentrated into one application in case of a Type 1 construction, such a strategy would generate one highly valuable filing and several ones of much less value. Hence, the expected sign of the association between construction strategies and patent value is uncertain.

Three, an additional feature of the European Patent System which has met an increasing success over the past two decades is the possibility to split one European application into several divisional filings that will follow their own track in the examination process while keeping the same filing date as the parent application from which they originate. This option is mostly used when the original application is said to lack unity and would hence be refused as such by the examiner. In such a scenario, the applicant may isolate different subsets of the initial claims and encapsulate them into different divisionals while the now smaller original filing follows its initial path up to grant, usually carrying the core of the claims. Therefore, the case of divisional filings usually reveals excessively large or unfocused applications, sometimes resulting from the premature patenting of an invention or from a deliberate willingness to deceive competitors and examiners by hiding the true invention in the middle of many non inventions or to maintain a case pending for as long as possible.

This way, divisional filings sometimes emerge as a new form of *de facto* submarine patents (Graham and Mowery, 2004; van Zeebroeck et al., 2006a; Stevnsborg and van Pottelsberghe, 2007). Indeed, although Article 76(1) of the European Patent Convention provides that divisionals "*may be filed only in respect of subject-matter which does not extend beyond the content of the earlier application as filed*", some applicants file divisional applications beyond this requirement to amend them later, during prosecution. Some even file divisionals of divisionals that they amend even later in the process. This has led to concerns that the divisionals system can be abused, thereby reducing legal certainty for third parties.⁹ Nonetheless, the administrative burden induced by the filing of divisionals suggests that such strategies would only be used when the root application is

⁷ Harhoff's Type II construction referring to the possibility for applicants to file independent priority filings covering a same invention and extend them to the EPO as such is much more difficult to identify for such applications are not related by common priority numbers.

⁸ Note that the computation of the *EQUIV* variable excluded from recognized equivalents those applications that were in fact divisionals of the original filing, see below.

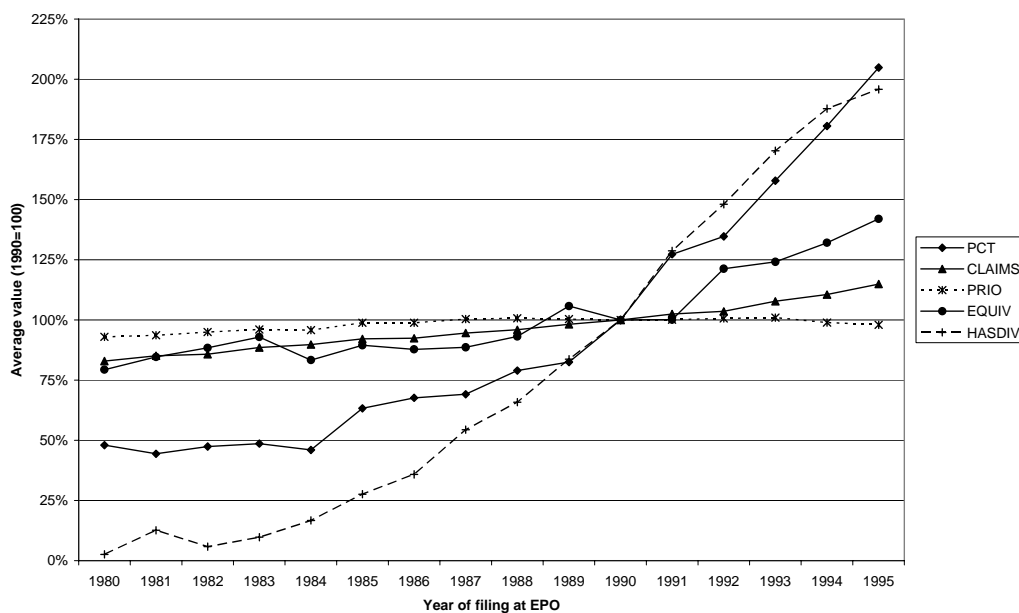
⁹ Nurton, J., "EPO Enlarged Board rules on divisionals", in MIP Weekly News July 4, 2007.

unusually valuable. Hence parents of divisionals are expected to be strongly associated with patent value. The sign of the association between divisional filings is much less clear, as no one could predict which part of the subject matter from the original filing (the core of the invention or some accessory features) will be encapsulated into each divisional. Should the two effects materialize (divisionals concern more valuable patents but most value remains within the original filing), the association should be ambiguous. From Table 1, one may notice that about 4% of all granted patents filed to the EPO in the period considered have given rise to divisional filings (*HASDIV*) and 3% only were divisionals themselves (*ISDIV*). Since by definition each parent has given rise to at least one divisional application, this difference readily suggests that divisional filings are less likely to be granted than their parents.

The numerous combinations of these different strategic dimensions induce different patterns described by Stevnsborg and van Pottelsberghe (2007) as fast vs. slow tracks and good-will vs. abusive behaviours. For example, a jumbo application (with an outrageous number of claims) followed by several generations of divisionals is clearly suggestive of an attempt to abuse the system and slow down the examination process as much as possible. To the contrary, a short application, filed to the EPO with a request for accelerated search or examination, quickly giving place to a granted patent with the exact same set of claims is a clear indication of a good-willing patentee whose application has been efficiently and honestly drafted.

Figure 1 depicts the evolution of the different dimensions of patent filing strategies for the period 1980-1995. It shows at first sight that all these strategies have become increasingly frequent over the period considered. The most striking evolutions are the share of applications filed through the PCT route and the share of applications which were followed by one or more divisional applications. With less pronounced an evolution, the average number of claims and of EP equivalents have also experienced a continuous increase over the entire period, whereas the average number of priorities has remained remarkably stable around 1 priority, suggesting that the construction by assembly, though more frequent nowadays than before, remains largely exceptional.

Figure 1 - Evolution of Patent Filing Strategies at the EPO (1980-1995)



Sample: All applications filed to the EPO in the period 1980-1995

Whereas most patent value indicators have decreased or remained mitigated over the same period,¹⁰ all strategic indicators exhibit a (sometimes severe) upward trend. These opposite evolutions could actually suggest a negative impact of filing strategies on patent value, against the common sense intuition evoked earlier in this section. This further emphasizes the need for an empirical investigation of this relationship.

3. The literature on patent value

The burgeoning empirical literature on patent value has been surveyed by Reitzig (2004), Sapsalis and van Pottelsberghe (2007) and Greenhalg and Rogers (2007).¹¹ A particularity of the numerous contributions in this field of research is that they cannot be easily summarized, as their empirical design diverge over three dimensions: i) in the measure of patent value used as dependent variable; ii) in the number and type of explanatory variables (i.e. the potential determinants of value), and iii) in the adopted sampling strategy. Most empirical implementations take the following form:

$$V_i = f(PC_i, PO_i, II_i) \quad (2)$$

Where V_i is a measure of the value of patent i , PC_i is the vector of characteristics of patent i , PO_i is the vector defining the characteristics of patent i 's ownership, and II_i is a vector of variables characterizing the underlying invention and the context in which it was made or patented. The heterogeneity across the literature comes from the various measures of V and from the numerous determinants within each of the three classes included in the empirical models.

Diversity in indicators of patent value

Roughly speaking, established measures of patent value used on the left-hand side of Equation 2 can be divided into two broad categories: those that come from outside the patent system and those that come directly from it, respectively 'market-based' and 'patent-based' measures, as summarized in Table 2. The former measures mainly consist of financial or economic indicators, the most popular being Tobin's q and stock market values for works at the firm level, and surveyed estimates for studies at the patent level. In the case of firm market values, the heroic underlying assumption is that the value of a firm's patent portfolio should be somehow reflected in its market value, provided that financial markets are efficient. In the case of the surveyed monetary value of patents, the underlying rationale is no less heroic as it assumes that inventors or managers know the financial value of their patents.

The latter group of measures, henceforth designated 'patent-based', are much more diverse in nature and rationale. Four indicators are most frequently used in the literature: forward patent citations, patent family sizes, survival (or renewal) data and legal disputes (oppositions or litigation). First, forward patent citations consist in counting the number of citations that each patent received from subsequent patent filings (Trajtenberg, 1990) and are hence easily and freely available from the search reports published by patent offices with each patent application. They are taken as indicators of value, or turn out to be highly correlated with financial value indicators, because they reveal subsequent inventions based on the cited patent. The fact that other companies enter into the same technological space or that the applicant pursues investments around a given invention indicates a potentially valuable market.

¹⁰ See van Zeebroeck (2007) and below in section 4.

¹¹ Reitzig (2004) discusses in particular the theoretical and conceptual meaning of various indicators and determinants.

Second, patent family sizes are made of the number of countries in which a given patent has been filed. Given the costs and administrative efforts required to obtain such international coverage, economists logically assume that wider international families of patents would denote higher value patents (Putnam, 1996). This indicator can be computed in several different ways: triadic patent families (Dernis et al., 2001) consist in patents that have been filed simultaneously at the USPTO, the JPO and the EPO, whereas counts of countries of protection may be obtained at different levels, e.g. worldwide or in terms of EPC member States where EPO granted patents were validated (van Pottelsberghe and van Zeebroeck, 2008).

Table 2 - Typology of patent value indicators in the literature

| Group | Indicator | Notation in Table 5 |
|-------------------------------|--|----------------------------|
| Market-based measures | | |
| Firm value | Tobin's <i>q</i> | <i>MKT</i> |
| | Stock Market | |
| | Sales/ Benefits | |
| | New firm creation | |
| | Technologic Strength | |
| Estimated patent value | R&D Performance | |
| | Royalties | |
| | Dollar assessment by inventors or managers | |
| | Sleeping vs. Active | |
| | Buy-outs | |
| Patent-based measures | | |
| Technological importance | Forward citations | <i>CIT</i> |
| Geographical scope (Families) | | <i>FAM</i> |
| | Triadic | |
| | Number of countries worldwide | |
| | Number of EPC validation States | |
| Length (Renewals) | Age at lapse | <i>REN</i> |
| | Patent has been granted | <i>GRT</i> |
| Legal disputes | | <i>DIS</i> |
| | Litigation incidences | <i>LIT</i> |
| | Opposition incidences | <i>OPP</i> |
| | Opposition outcomes | <i>OTC</i> |

Third comes the age at which patents ultimately fall into the public domain (or lapse), namely their lifespan or duration, which provides one of the most appealing indicators of value, whose theoretical foundations have been provided by Dernburg and Gharrity (1961) and Pakes and Schankerman (1984). As renewal fees are requested each year to keep a patent active, patents that are renewed for several years are considered to be 'worth it'. If one wants to consider not only patent grants but also all non-granted applications filed within patent portfolios, one should first acknowledge that only granted patents will ever be renewed, and that the grant of a patent determines its enforceability. The positive outcome of granting procedures has therefore been used as an alternative indicator of patent value (Guellec and van Pottelsberghe, 2000). Note anyway that most empirical studies on patent value – including the present one – only take into account patents which have been granted.

The fourth indicator of value is related to the occurrence of legal disputes, mostly litigation in the US (increasingly frequent according to Bessen and Meurer, 2005) and oppositions in Europe.¹² Both types of disputes have been intensively used as revealers of high value patents, as they generally concern inventions that are already exploited on the market place.

Table 3 proposes a typology of the empirical studies available so far on patent value, based on the value indicator used and the sample construction method (Table A1 in the appendix provide the names of the authors of the studies depicted in Table 3). It appears first that some indicators of value are much more popular than others, namely market-based measures, citations and oppositions.

¹² Post-grant review systems and their advantages have been carefully examined by Hall et al. (2003).

Second, many indicators have never been used at a large scale (this is logically the case for market value measures over a full sample, since such measures can only be gathered manually – hence selectively – at the patent level). Third, very few studies have relied on full samples of patents, i.e. without making any arbitrary choice on the sample construction to be made. Focused approaches are clearly the most frequent, with 35 studies at the patent level and 14 at the firm level. As the joint information on patent and firm characteristics is not easy to obtain, focused approaches are a logical solution.

Table 3 - Typology of the empirical literature on patent value

| | | | | | | | | | |
|----------------------------------|--------------------------------|---|--------------------------------------|-------------------|---|---------------------------|---|-----------------|---------|
| Sample used in estimation | Patent-level full-scale | GVP00 GVP02 PJV05 WPJ07 | | | | | | | B05 D05 |
| | Patent-level focused | A93** CC80** CNW81* L98** L93** LPP98** P03** S05* S01** ST04* TF94* | L94** SVP07** SVPN06** S07* | S06* | CS04° GHHM02° HH02° HR04° JW03° R04a** R04b° W04° | GHHM02° R04b° | AL98* ALMT03* C04* LS97* LS99** LS01* L94** | B06** LS99** | |
| | Patent-level survey | AANM91** PATVAL06* G05* GHV06* HSV02* HSV03* R02 R03° | | HNSV99* JTF00* | | | | | |
| | Firm-level focused | B06** BVR02* BR01* CHO05 GJW05* GPH86 HC03° HJT05** LS04* L94** NS06** SK97° T90** | | N04** | | | | | |
| | Firm-level survey | NNP87** | BCM07* | BCM07* | | DI97* | | | |
| | Aggregate level | ACC04** P86* PS84 PS89* P96 S98* SP86* S94* | | HH04 | | | | | |
| | | Market Value | Citations | Grants | Opposition | Opposition Outcome | Litigation | Renewals | |

Indicator used as dependent variable

*Geographical sample | *Sectoral sample | Acronyms are detailed in Table A1 in the appendix
The term 'Focused' refers to samples limited to a few sectors and/or countries

Diversity in sampling strategies

Despite the richness of the empirical literature, there are as many samples as papers. First, sampling strategies vary widely, from a few dozens observations in studies at the aggregate level to full-scale samples with up to tens of thousands of patents. Many papers work at the patent level, but many others test value indicators at the firm level, while a few others study patent value at the industry or country level. Second, most samples are limited to one specific country or industry. They are called 'focused' samples in opposition with full-scale samples, which comprise a full cohort of patents from one patent office, no matter the country or industry. Obviously, samples based – even partially – on the answers to any survey are constrained by the unavoidable selection inherent to any survey. The different levels of observation (aggregate, firm, or patent) and types of samples (surveyed, focused or full-scale) are represented on the vertical axis in Table 3. It clearly appears that 'focused' approaches are by far the most frequently used. These studies are most frequently limited to a particular industry in a given country. One may logically wonder to what extent the empirical results found in such 'focused' pieces of research can be generalised.

Diversity in the determinants

Summarizing the literature is complex not only for the diversity of dependent variables that have been used or for the high heterogeneity in the sampling strategies, but also because the type and number of explanatory variables vary widely across studies. To start with, some explanatory variables which are significantly correlated with an independent value measure of proven reliability have subsequently been used as new indicators of value on their own. This has been the case for instance with forward patent citations, which are the most important determinant of patent value for

market-based measures but have been used as dependent variable in at least 8 studies. This is also the case with renewals and legal disputes. In addition to these measures with well established though imperfect reliability, the authors have identified a range of extra features or characteristics of patents as new potential value determinants, which can be grouped into the three different classes of variables introduced in Equation 2: various characteristics of each patent application, the characteristics of patent owners, and some contextual information gathered from surveys, pertaining to the context of the invention or the patenting motives pursued by the applicant. This typology of patent value determinants is summarized in Table 4.

Table 4 - Typology of patent value determinants

| Group | Determinant | Notation in Table 5 | |
|---|---|----------------------------|------------|
| Patent characteristics (PC) | | | |
| Technological importance | Forward citations (after N years) | <i>CIT</i> | |
| | Number of X or Y citations (after N years) | | |
| | Institutional origin of forward citations | | |
| Geographical scope (Families) | Triadic | <i>FAM</i> | |
| | Number of countries worldwide | | |
| | Number of EPC validation States | | |
| Length (Renewals) | Age at lapse | <i>REN</i> | |
| | Granted | <i>GRT</i> | |
| Legal disputes | | <i>DIS</i> | |
| | Litigation incidences | <i>LIT</i> | |
| | Opposition incidences | <i>OPP</i> | |
| | Opposition outcomes | <i>OTC</i> | |
| | Multiple opponents | <i>MOP</i> | |
| Complexity | Number of backward patent citations | <i>BPC</i> | |
| | Share of Self Citations (by same applicant) | | |
| | Generality index | | |
| | Basicness/Originality index | | |
| | Number of backward non-patent citations | | <i>NPC</i> |
| | Number of claims | | <i>CLM</i> |
| | Number of IPC classes (at different levels) | | <i>IPC</i> |
| | Number of inventors listed | | <i>INV</i> |
| Filing route | PCT (Chapter I/Chapter II) vs. EP Direct | <i>PCT</i> | |
| | Accelerated Search Request | <i>ASR</i> | |
| | Accelerated Examination Request | <i>AEX</i> | |
| Patent Ownership (PO) | | | |
| Ownership structure | Co-Applicants | <i>COA</i> | |
| | Cross-border ownership | <i>CBO</i> | |
| Applicant profile | Portfolio size | <i>CUM</i> | |
| | Market size | <i>APS</i> | |
| | Academic | <i>ACA</i> | |
| | Independent | <i>APP</i> | |
| | Inexperience | <i>OCC</i> | |
| | | | |
| Insider information (from surveys only) (II) | | | |
| Patenting motives | | <i>MOT</i> | |
| | Offensive vs. Defensive | | |
| | Blocking vs. Protection | | |
| Invention context | Research Collaboration | <i>ICH</i> | |
| | | | |
| | Difficulty to invent around | | |
| | Inventors' profiles | | |
| | R&D Structure | | |
| | Environment | | |

The class of determinants based on patent characteristics include different subsets of variables with very different rationales. The first four subsets correspond to the four groups of patent-based indicators described here above, which have been used on both sides of Equation 2: forward citation counts (and derived measures), measures of the geographical scope (patent families), measures of the length (renewals), and variables identifying legal disputes, their characteristics and outcomes. The rationale of these four subsets of variables has been detailed here above and all suggest a positive association with patent value which has already been established. These four types of

measures will constitute the dependent variables for the model presented in the next section and will therefore only be used as indicators (i.e. on the left-hand side of Equation 3) in this paper.

However, two additional subsets of determinants in the same class have been widely tested in the literature: measures of complexity and indications on the filing route followed. The former set includes backward patent citations (indicating the existing market potential of the invention) and derived measures,¹³ non patent citations (denoting the link of the invention to basic research (Carpenter et al., 1980; Narin et al., 1987)), the number of claims (supposedly informative on the legal breadth of the protection (Tong and Frame, 1994)), the number of IPC classes (a proxy for the technological scope or architectural nature of the invention (Lerner, 1994)), and the number of inventors listed in the application (indicating the research effort made to design the invention (Reitzig, 2004a,b)). All those complexity indicators are expected to be positively correlated with patent value and have proved so in some empirical studies. The latter set summarizes the path followed by each application to reach a given patent office and is considered in the present paper as fully part of its filing strategy discussed in section 2. The corresponding variables will therefore be included in our model as dimensions of filing strategies.

The second class of determinants represent the characteristics of a patent's ownership. This class first includes the structure of the ownership: the presence of multiple applicants introduced by Duguet and Iung (1997) denotes joint research efforts, and the cross-border ownership of patents (i.e. at least one inventor and one applicant residing in different countries) established by Guellec and van Pottelsberghe (2000) indicates an international organization of research. Both measures are expected to be associated with more valuable inventions and thus to be positively correlated with patent value. The second set of determinants in this class act as 'qualifiers' for the applicant and include different measures. One, the market size of the applicant (Lanjouw and Schankerman, 1997) has an ambiguous relationship with patent value (larger firms may produce higher quality research but may also be less discriminating in choosing which invention to patent or not). For the same reason, independent inventors (Gambardella et al., 2006) also have an unclear expected relationship with patent value. Two, academic patents (Harhoff et al., 2002) are thought to relate to more basic research, which is expected to produce higher value inventions. But universities do not necessarily choose which invention to make and to patent on the basis of its market potential, hence academic patents might be of a higher scientific value but of a lower market value, and the association between this academic nature of an applicant and patent value is therefore expected to depend on the indicator. Three, the inexperience of a patentee with the patent system (Allison et al., 2003) may be the sign of a highly valuable invention (valuable enough to convince a newcomer to enter the patent arena) or of a small invention that did not pass a careful screening prior to being patented. As a result, here again the expected relationship of this determinant with patent value is unclear. And four, the size of the applicant's patent portfolio (Shane, 2001) has also been included in many empirical models. On the one hand, the larger this number, the more experienced the applicant should be with the patent system and the most valuable his patents could be. On the other hand, very large portfolios may be a sign of patentees who have a very high propensity to patent, possibly inducing many applications of lower value to be filed. Therefore, the expected sign of the association between portfolio sizes and patent value is undetermined.

As a complement to the richness of the information available from patent databases, various dimensions of the inventing and managerial processes underlying a patent have been explored thanks to inventors surveys, providing some sort of 'insider information' on the context in which a

¹³ Czarnitzki et al. (2005) and Hall et al. (2005) observe that self backward patent citations (i.e. made to patents owned by the same individual or firm) are more valuable than citations coming from third-party patents, while Palomerias (2003) and Sapsalis and van Pottelsberghe (2007) obtain more nuanced results, except for self non-patent citations.

given invention was made and on the motivations to patent it. These variables make the third class of patent value determinants, which is more in an embryonic state so far. A large scale example of such surveys has been conducted in Europe a few years ago under the name PatVal, the authors of which gathered detailed information on about 9000 European patents and their underlying invention (Gambardella, 2005; Brusoni et al., 2006; Gambardella et al., 2006).¹⁴

Consistency across the empirical literature

The main results obtained by most contributing papers in the field are summarized in Table 5, which shows the number of empirical estimates in which each potential value determinant appeared associated with each potential indicator. At first sight, some areas appear obviously much more crowded than others. It first confirms that the most popular indicators used as dependent variables are market value indicators with 71 estimated parameters (at the patent or firm level), followed by oppositions and forward citations, with respectively 67 and 24 estimated parameters. This last variable is however the most frequently used determinant, followed by families, backward patent citations and claim counts, then renewals, IPC classes, PCT, the size of the applicant, non-patent references, and patent portfolio sizes.

A closer look at the table shows that many inconsistencies have burgeoned in the literature. Whereas renewals and forward citations have almost always been positively associated with patent value indicators, backward patent citations and even more so backward non-patent references, claims, and IPC classes – not to mention many less frequently tested measures – seem to have a much more ambiguous or instable relationship with the different value indicators. All these results and the notable inconsistencies that have appeared across the various settings and models tested in the literature call for a more comprehensive exercise conducted at the largest possible scale to investigate any potential indicator, geographical or industrial patterns in the observed correlations.

Table 5 – Empirical evidence on value indicators so far

| | Value Indicators | | | | | | | | | | | | T | W | | | | | | | | | | | | | | | | | | | | | |
|-------|------------------|----|----|----|-----|---|----|----|-----|---|---|----|----|---|-----|----|----|---|-----|----|----|---|-----|----|---|---|-----|----|----|----|----|----|---|---|---|
| | MKT | | | | CIT | | | | GRT | | | | | | OPP | | | | OTC | | | | LIT | | | | REN | | | | | | | | |
| | A | N | P | T | A | N | P | T | A | N | P | T | | | A | N | P | T | A | N | P | T | A | N | P | T | A | N | P | T | A | N | P | T | |
| MKT | | | | 0 | | | | 2 | 2 | | | | 0 | | | | 0 | | | | 0 | | | | 0 | | | | 0 | | | | 0 | 2 | 2 |
| CIT | 1 | 14 | 15 | | | | | 0 | 2 | 1 | 3 | 2 | 6 | 8 | | 1 | 2 | 3 | | | | | 5 | 5 | | 3 | 3 | | 3 | 37 | 33 | | | | |
| FAM | 1 | 4 | 5 | 2 | | | | 2 | 1 | 2 | 3 | 2 | 6 | 8 | 3 | | | | 3 | | | | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 25 | 21 | | | | |
| REN | | | | 13 | 13 | | | | 1 | 1 | | 0 | 1 | 1 | | | | | 0 | | | | 0 | 0 | | | | | 0 | 15 | 15 | | | | |
| DIS | | | | 4 | 4 | | | | 0 | 0 | | 0 | 0 | 0 | | | | | 0 | | | | 1 | 1 | | 1 | 1 | | 1 | 6 | 6 | | | | |
| MOP | | | | | | | | | 0 | 0 | | 0 | 0 | 0 | | | | | 1 | 1 | 2 | | | | 0 | 0 | 2 | | 1 | 0 | 2 | 1 | | | |
| BPC | 1 | 3 | 4 | | | | | 3 | 3 | 2 | 1 | 3 | | | | 5 | 5 | 1 | | | | 1 | 1 | 3 | 2 | 5 | 2 | 2 | 23 | 21 | | | | | |
| NPC | 1 | 2 | 3 | 2 | | | | 1 | 3 | | | 0 | 4 | 1 | 5 | 1 | | | | 1 | 1 | | 1 | 1 | | 0 | 13 | 12 | | | | | | | |
| CLM | 1 | 3 | 4 | | | | | 2 | 2 | 1 | | 1 | 2 | 5 | 7 | 1 | 1 | 1 | 2 | | | | 5 | 5 | 1 | 1 | 22 | 19 | | | | | | | |
| IPC | 1 | 3 | 4 | | | | | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 1 | 3 | | | | 0 | 2 | 1 | 3 | | | | 0 | 14 | 12 | | | | | | |
| INV | | | | 1 | 1 | | | | 1 | 1 | | 2 | 2 | 2 | | | | | | 1 | 1 | | 0 | 0 | | 0 | 6 | 5 | | | | | | | |
| PCT | | | | 0 | 0 | | | | 0 | 1 | 2 | 3 | 4 | 3 | 7 | 3 | 3 | 1 | | 3 | 1 | | 1 | 1 | | 0 | 14 | 11 | | | | | | | |
| AEX | | | | 0 | 0 | | | | 0 | 0 | | 0 | 5 | 5 | 2 | 1 | 3 | | | | 0 | 0 | | 0 | 0 | | 0 | 8 | 5 | | | | | | |
| ASR | | | | 0 | 0 | | | | 0 | 0 | | 0 | 1 | 2 | 3 | 1 | 1 | 2 | | | | 0 | 0 | | 0 | 0 | | 0 | 5 | 3 | | | | | |
| COA | | | | 0 | 0 | | | | 2 | 2 | | 1 | 2 | | 2 | 1 | 1 | | | | 0 | 1 | | 1 | 1 | | 1 | 7 | 6 | | | | | | |
| CBO | | | | 0 | 0 | | | | 0 | 0 | | 0 | 2 | 2 | | | | | | 0 | 0 | | 0 | 0 | | 0 | 2 | 2 | | | | | | | |
| CUM | 2 | 2 | 4 | | | | | 1 | 1 | | 2 | 2 | 2 | 1 | 3 | | | | | 0 | 2 | | 2 | 2 | | 0 | 12 | 11 | | | | | | | |
| APS | 2 | 1 | 2 | 5 | | | | 1 | 1 | | 0 | 1 | 1 | 1 | 3 | | | | 2 | 2 | 2 | | | | 2 | 1 | 1 | 14 | 12 | | | | | | |
| ACA | | | | 1 | 1 | | | | 0 | 0 | | 0 | 1 | 1 | 1 | | | | | 0 | 0 | | 0 | 0 | | 0 | 2 | 2 | | | | | | | |
| APP | 1 | | | | | | | 0 | 1 | | 1 | | | | 0 | | | | 0 | 1 | | 1 | 1 | | 0 | 3 | 2 | | | | | | | | |
| OCC | | | | 0 | 0 | | | | 0 | 0 | | 0 | 0 | 0 | | | | | | 0 | 0 | | 1 | 1 | | 0 | 1 | 1 | | | | | | | |
| MOT | | | | 0 | 1 | | | | 1 | | 1 | | 1 | | 0 | | | | 0 | 0 | | 0 | 0 | | 0 | 2 | 1 | | | | | | | | |
| DIA | | | | 1 | 1 | | | | 0 | 0 | | 0 | 0 | 0 | | | | | | 0 | 0 | | 0 | 0 | | 0 | 1 | 1 | | | | | | | |
| ICH | 3 | | | 3 | | | | 0 | 0 | | 0 | 0 | 0 | | | | | | 0 | 0 | | 0 | 0 | | 0 | 3 | 3 | | | | | | | | |
| TOTAL | 13 | 4 | 51 | 68 | 6 | 1 | 12 | 19 | 9 | 7 | 6 | 22 | 24 | 7 | 33 | 64 | 13 | 5 | 6 | 24 | 10 | 2 | 17 | 29 | 5 | 0 | 6 | 11 | | | | | | | |
| W | | | | 38 | | | | 8 | | | | 5 | | | | 9 | | | | 2 | | | | 7 | | | | 4 | | | | 66 | | | |

A: Ambiguous, N: Negative, P: Positive, T: Total, W: Distinct Works

¹⁴ Earlier examples in the US included Scherer (1965), Carpenter and Narin (1983), Narin et al. (1987), Albert et al. (1991), Cohen et al. (2000), and Jaffe et al. (2000) and in Europe, Crépon et al. (1996), Duguet and Jung (1997), Harhoff et al. (1999, 2002, 2003), Scherer and Harhoff (2000), Scherer et al. (2000), Kleinknecht et al. (2002), Reitzig (2002, 2003), and Silverberg and Verspagen (2004).

Finally, one may notice that the dimensions of patent filing strategies discussed in section 2 have hardly (if at all) been accounted for in the existing literature, besides a few exceptions with filing routes. The next section precisely aims at testing the association between the filing strategy indicators presented in section 2 and different measures of patent value.

4. Empirical implementation

To analyze the association between filing strategies and patent value and to test the robustness of some classical variables as determinants of patent value, a specific dataset needed to be constructed from different sources: OECD (2004), PATSTAT (2006), Harhoff (2006) and different internal EPO databases. Due to data truncation and timeliness issues (the measurability horizon of most value indicators is about 10 years) this dataset is composed of all applications filed to the EPO between 1990 and 1995 that were granted by the Office no later than in January 2006. This makes a total of about 250,000 European patents.

The model to be estimated is an extension of the classical model represented by Equation 2:

$$V_i = f(FS_i, PC_i, PO_i, CV_i) \quad (3)$$

Where FS_i is the vector of variables characterizing the filing strategy adopted by patent i 's applicant and CV_i is a vector of dummy control variables. The endogenous and exogenous variables included in the model are described in what follows.

Dependent variables (value indicators)

Since our objective was to perform an econometric analysis at the patent level and on a full-scale basis, our dataset is limited to the information that can be found within patent databases, therefore excluding any market value as dependent variable. However, in order to obtain results that would be independent to the indicator chosen, a multi-indicator approach is preferred, in which the same model will be estimated with different indicators as dependent variables (V). Building on a companion paper (van Zeebroeck, 2007), five classical indicators are used in order to approximate patent value on the left-hand side of the models, which represent the four different types of patent-based value measures discussed in section 3: the number of forward citations received by each application within 5 years from its filing date ($CITE5$),¹⁵ the number of EPC Contracting States in which the granted patent has been validated after grant ($EPCFM$),¹⁶ whether the patent was still enforced in at least one EPC Contracting State 10 years after it had been filed ($SRV10$), whether the patent is a member of a triadic patent family (i.e. has been applied for or granted at the USPTO and JPO)¹⁷ ($TRIAD$), and whether the granted patent has been opposed at the EPO ($OPPOS$). Note that the two former indicators are discrete variables and the three latter are binary. In addition, a sixth indicator ($COMPO$) is made of the composite value index ranging from 0 to 20 defined by van Zeebroeck (2007) according to Equation 4:

$$CV_i = \max \left\{ r \left[\max \left\{ \frac{SYI_i}{10} - 2; 0 \right\} + 2.TRI_i + C_i + 2.OPP_i + 3.REJ_i - 2.REV_i - 1 \right]; 0 \right\} \quad (4)$$

¹⁵ See Webb et al. (2005) for a detailed overview of the main issues with patent citations data.

¹⁶ Using EPO databases for renewals, validation records with a lapse within the first year from the date of grant are discarded as they denote in fact lapses 'ab initio' (see van Zeebroeck, 2007).

¹⁷ See Dernis et al. (2001), Dernis and Khan (2003) and Webster et al. (2007)

Where CV_i is the composite value of application i , $r(x)$ is a function that rounds its given parameter to the closest integer, SYI_i is the Scope-Year index (a composite measure of the geographical scope and term of maintenance defined in van Pottelsberghe and van Zeebroeck (2008)), TRI_i is a dummy variable equal to 1 if application i is a triadic one and 0 otherwise, OPP_i is a dummy variable taking value 1 if the application has been opposed and 0 otherwise, REJ_i is equal to 1 if the opposition was rejected or closed, and REV_i takes value 1 if the application was revoked as a result of the opposition procedure. Finally,

$$C_i = \begin{cases} (1 + \ln(CITE5_i)) & \text{if } CITE5_i > 0 \\ 0 & \text{if } CITE5_i = 0 \end{cases} \quad (5)$$

By its definition, this indicator balances the five dimensions represented by the five indicators listed above. As such, this composite value indicator may be expected to provide a synthetic view of the aggregate effect of each explanatory variable in the model, should these effects differ from one indicator to the other.

Table 6 - Summary Statistics of Endogenous Variables

| Variable | Obs. | Mean | St. Dev. | Min | Max | Model |
|----------|---------|------|----------|-----|-----|-----------|
| TRIAD | 248,856 | 0.66 | 0.47 | 0 | 1 | Probit |
| SRV10 | 243,894 | 0.50 | 0.50 | 0 | 1 | Probit |
| OPPOS | 248,856 | 0.06 | 0.24 | 0 | 1 | Probit |
| CITE5 | 248,856 | 0.56 | 1.19 | 0 | 46 | Neg. Bin. |
| EPCFM | 243,886 | 5.38 | 3.51 | 1 | 16 | Poisson |
| COMPO | 248,856 | 3.54 | 2.79 | 0 | 18 | Neg. Bin. |

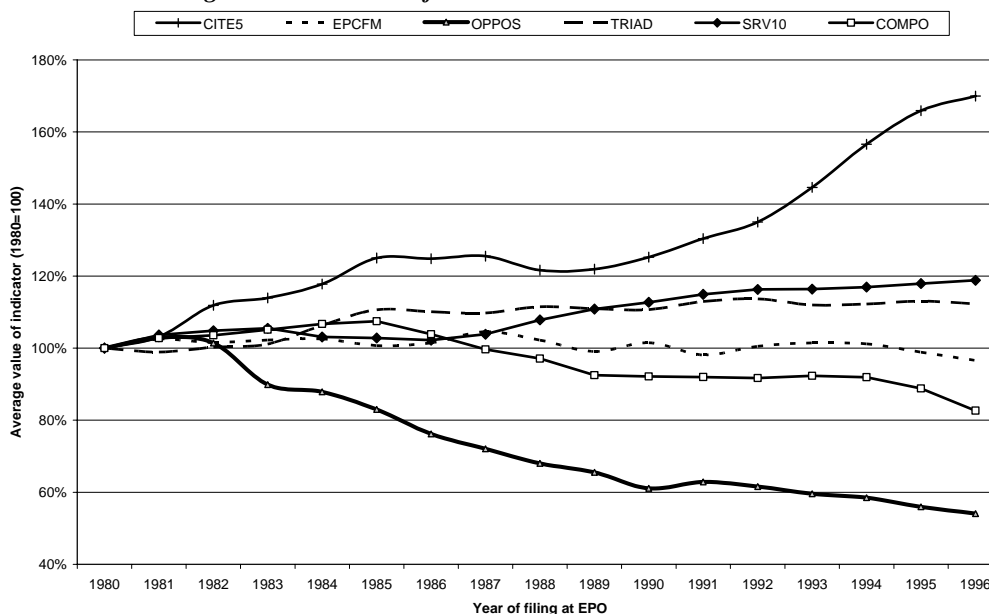
Source: Own calculations based on EPO data – Granted patents filed 1990-1995

Summary statistics of these six dependent variables are provided in Table 6. It shows that about 66% of patents in the sample belong to a triadic family, 50% have been maintained for at least 10 years from their filing date, and 6% have been opposed. The average number of citations received within 5 years is about 0.5 with a minimum (and mode) of 0 and a maximum of 46, the number of EPC Contracting States in which patents in the sample were validated ranges from 1 to 16 with an average of over 5 countries,¹⁸ and the average composite value in the sample is about 3.54, ranging from 0 to 18. The evolution of these six indicators over time is depicted in Figure 2. As discussed in van Zeebroeck (2007), most of the indicators have experienced some decrease in value between 1985 and 1995, with the exceptions of the number of citations and the rate of 10-year survival which have increased, and the share of triadic patents which has remained stable. Hall et al. (2001) nevertheless observe that the increase in the number of forward citations is probably influenced by systemic factors which may not be associated with any increase in value (essentially relating to changes in the nature and creation of citations), and van Zeebroeck (2007) points out that the increase in the rate of 10-years survival is tempered by a contraction in the geographical scope of protection and a dilatation of the grant lag.

The model described in Equation 3 will be regressed on each of these 6 value indicators, using probit regressions for dummy variables and maximum likelihood estimations for discrete ones, with a Poisson specification for *EPCFM* and a negative binomial distribution for citation counts and the composite index.

¹⁸ Note that data on validations and renewals at the Italian Patent Office are excluded due to data unavailability.

Figure 2 - Evolution of Patent Value Indicators 1980-1995



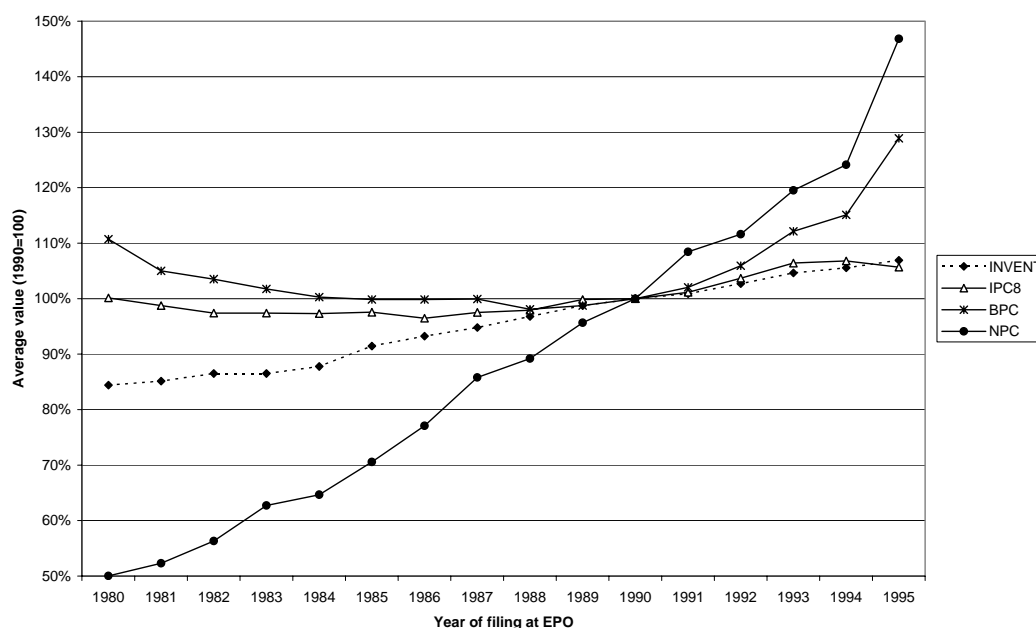
Sample: All applications filed at EPO in the period 1980-1995

Explanatory variables (value determinants)

The present model extends the classical one in the sense that it adds to Equation 3 the indicators of filing strategies introduced in section 2, representing filing routes and drafting styles. However, as compared with Equation 3, the present model excludes any insider information (*II*) due to the size of the dataset used, and uses the first four sets of patent characteristics only on the left-hand side of the equation as indicators of patent value. This leaves only measures of complexity from the class of patent characteristics, and the different measures of patent ownership (structure and profile). To complete the model, three sets of binary control variables will allow to account for potential industry, country and time effects. Descriptive statistics for the complexity, ownership, and control variables are provided in Table A2 in the appendix.

The complexity measures (*PC*) included in the model include four variables: the number of inventors listed in the application (*INVENT*), ranging from 1 to 32 with an average of 2.4 inventors; the number of IPC classes at 8 digits associated with the patent (*IPC8*), a number ranging from 1 to 43 with an average of about 2 classes per patent; the number of references made by each patent to earlier patent documents (*BPC*), ranging from 0 to 99 with about 4.5 backward citations on average, and the number of references made by each patent to non patent documents such as scientific papers (*NPC*), which has a maximum of 61 and an average of about 1 non patent citation per patent. The evolution of these four complexity measures is depicted in Figure 3. It shows that most complexity indicators have increased in the period 1980-1995, especially the number of patent and non patent references to the existing state of the art. This may reveal that inventions are becoming more incremental or architectural nowadays – an intuition which is supported by the concomitant but slower increase in the number of IPC classes and inventors – but may also be driven by systemic factors such as better electronic documentation and search techniques allowing examiners to more easily find relevant pieces of the prior art. As reviewed in section 3, the theoretical foundations of these four variables suggest that they should be positively associated with patent value, but the numerous empirical models found in the literature have produced many ambiguous results. The present implementation, conducted over a large sample and with 6 different value indicators, will allow sensitivity tests to the indicator and the sample to be performed.

Figure 3 - Evolution of the complexity of patent applications



The ownership characteristics (*PO*) included in the present model account for most determinants in this class: *CUMUL* gives the total number of applications filed to the EPO by the same applicant in the same year and the five previous years (in addition to the application being considered), providing an overview of the cumulative portfolio size of the applicant (van Zeebroeck et al., 2006a), which represents on average about 410 EPO applications with a maximum of 4832. *OCCAS* is a dummy variable taking value 1 if the cumulative portfolio size (*CUMUL*) is 0 (in which case the application being considered is the first one applied by the same applicant over the past 5 years) and 0 otherwise. This variable therefore identifies those filings made by inexperienced patentees, which was the case for about 21% of the patents in the sample. *ACAD* is a dummy variable identifying patent applications originating from academic institutions and public research centres, which represents about 2% of all patents in the sample.¹⁹ Finally, *CBOWN* is a dummy variable identifying patents with at least one applicant residing in another country than the country of one inventor, also known as cross-border ownership (Guellec and van Pottelsberghe, 2000). This is the case with about 1 patent out of 10 in the sample and should be related with higher value patents as they denote an international organization of research activities.

To complete the model and account for potential industry, country, or time effects, three sets of dummy variables have been constructed as control variables (*CV*): 14 dummy variables represent the 14 Joint Clusters representing different technological areas at the EPO (Archontopoulos et al., 2007), 19 country dummies identify the country of residence of the applicants, and 6 year dummies represent the year of filing of each patent at the EPO (ranging 1990 to 1995). The three sectors with the largest number of patents granted from the sample are ‘handling and processing’, ‘organic chemistry’ and ‘industrial chemistry’, with 14, 13 and 12% of the patents respectively, and the 3 largest countries of residence of applicants represent about 70% of the sample (the US, 26%; Japan, 22%; and Germany, 20%). With about 9% of the sample, France is clearly lagged by the three largest countries, but well before the UK (5%), the Netherlands and Switzerland (4% each), and Italy (3%). Note that the sample is well balanced over the period considered as 16 to 17% of the patents had been filed in each of the 6 years in the period.

¹⁹ This variable has been created based on the presence of the roots of the words “University”, “Institute” and “Centre” in the name of the applicant. It is therefore largely imperfect and should be interpreted with care.

5. Empirical results

The main results of the six model estimations are provided in Table 7. The first observation to be made is that most parameters are significant and positive, evidencing that patent filing strategies are positively correlated with patent value. Generally speaking, the log-deviation in claims (*CLMDEV*), the number of priorities (*PRIO*), the parents of divisionals (*HASDIV*), and the PCT route (*PCT*) are associated with the most significant parameters across all indicators. Nonetheless, some discrepancies appear across indicators that are worth being emphasized.

Filing strategies

According to most papers, the number of claims is positively associated with patent value, although it has been reported as non significant or at least ambiguous in a few papers²⁰ and even negative in one.²¹ Consistently with most the literature, the log-deviation in claims is associated with a significant and positive coefficient on all six value indicators. But whereas it is among the 2 or 3 most significant parameters of the model in five cases out of six (especially with the number of citations and the composite indicator), it appears relatively less significant with the likelihood to be opposed. It sounds therefore logical that the share of claims abandoned in the course of the examination has a detrimental effect on patent value, except that it does not reduce anyhow the likelihood to be opposed. With other words, the number of claims seems strongly related with patent value. Patents with excess claims are associated with more citations (arguably because the scope of the patent is then larger and hence increases the probability that future applications will overlap with it), tend to be applied for in more countries within and outside the EPC, and tend to live longer. However, claims have much smaller an effect on oppositions. This result may arguably be seen as surprising since the main objective of oppositions is to reduce or destroy the legal scope of protection provided by a patent, which is made of the claims. In a nutshell, this result suggests that opponents target the substance defined by the independent claims rather than the subtleties such as fall back positions (mostly made of dependent claims) of a patent.

The two constructionism variables differ in significance but not in sign across indicators. Their correlation with patent value is positive in most cases but insignificant with some indicators. The number of priorities is associated with a particularly strong positive coefficient for citations, triadicness and composite value, but – consistently with the claims – has no effect on oppositions. Conversely, the number of equivalents is associated with a positive coefficient on all indicators, including oppositions, but except on the number of citations. The interpretation of these results is not straightforward.

A patent linked to a larger number of priorities can be seen as an aggregate of several domestic first filings. If one assumes that its scope may therefore be larger than the standard application, it might explain why they tend to receive more citations from subsequent applications. This extra substance embedded into the patent may also explain why it tends to be validated in more countries in and outside Europe and why it seems more likely to be still active after 10 years. However, that such patents are not more likely to be opposed suggests that their complex construction does not increase the probability that a third party will find them embarrassing enough to incur the costs and risks associated with filing an opposition. Should this reasoning be true, there would be no reason to believe that patents with sibling (equivalent) EP filings should receive more citations, hence the non significance of the parameter on the number of citations might have been expected. But their belonging to a kind of bundle of filings aimed at protecting a same core invention shows that the applicant found the invention important enough to opt for this costly construction strategy. It would

²⁰ Lanjouw and Schankerman, 1999; Graham et al., 2002; Schneider, 2006; Calderini and Scellato, 2004; Wagner, 2004.

²¹ Palomeras, 2003.

then seem consistent that the applicant extends its patent to more countries and maintain it for longer as is suggested by the econometric results. In particular, this strategy is strongly associated with triadic patents. The higher likelihood for such patents to be opposed may reveal that at least some of the patents in the family are expanding the scope of protection in such a way that third parties are more likely to find one of the members embarrassing.

Table 7 – Econometric estimates for the 6 indicators of patent value

| Variables | 5yrs Citations | | EPC Family | | Triadic | | Survived 10yrs | | Opposed | | Composite | |
|--|----------------|-------------|------------------|--------------|---------------|-------------|----------------|-------------|--------------|-------------|--------------|-------------|
| | Coef. | z | Coef. | z | Coef. | z | Coef. | z | Coef. | z | Coef. | z |
| Patent Filing Strategies | | | | | | | | | | | | |
| ln(CLMDEV) | 0,29 | 45,64 (**) | 0,03 | 19,18 (**) | 0,10 | 20,79 (**) | 0,07 | 17,33 (**) | 0,03 | 4,47 (**) | 0,10 | 39,77 (**) |
| CLMLS | -0,02 | -7,00 (**) | -0,01 | -12,73 (**) | -0,03 | -8,49 (**) | -0,01 | -2,36 (*) | 0,01 | 1,66 | -0,01 | -9,97 (**) |
| PRIO | 0,10 | 20,63 (**) | 0,01 | 6,38 (**) | 0,20 | 34,70 (**) | 0,03 | 7,01 (**) | 0,00 | 0,85 | 0,03 | 17,54 (**) |
| EQUIM | 0,01 | 1,25 | 0,01 | 3,13 (**) | 0,12 | 15,63 (**) | 0,04 | 6,19 (**) | 0,04 | 5,52 (**) | 0,02 | 7,32 (**) |
| HASDIV | 0,23 | 13,68 (**) | 0,12 | 27,62 (**) | 0,20 | 11,39 (**) | 0,33 | 22,93 (**) | 0,30 | 15,61 (**) | 0,20 | 27,34 (**) |
| ISDIV | -0,28 | -10,20 (**) | 0,03 | 5,38 (**) | 0,45 | 19,20 (**) | 0,44 | 23,69 (**) | 0,11 | 3,73 (**) | 0,12 | 11,35 (**) |
| PCT | 0,09 | 9,59 (**) | 0,09 | 44,08 (**) | 0,28 | 39,40 (**) | 0,07 | 11,46 (**) | 0,01 | 0,70 | 0,14 | 37,44 (**) |
| ACCSR | 0,07 | 2,46 (*) | 0,04 | 5,18 (**) | 0,07 | 3,00 (**) | 0,17 | 7,97 (**) | 0,12 | 3,61 (**) | 0,06 | 5,23 (**) |
| Applicant Profiles | | | | | | | | | | | | |
| CUMUL | 0,01 | 1,23 | -0,05 | -37,40 (**) | 0,13 | 35,13 (**) | 0,02 | 6,70 (**) | -0,11 | -17,72 (**) | -0,02 | -8,55 (**) |
| OCCAS | -0,06 | -5,73 (**) | 0,04 | 16,55 (**) | -0,39 | -53,23 (**) | -0,13 | -18,63 (**) | 0,08 | 7,90 (**) | -0,07 | -16,28 (**) |
| ACAD | 0,08 | 3,24 (**) | 0,00 | 0,34 | -0,13 | -5,63 (**) | -0,05 | -2,31 (*) | -0,11 | -3,40 (**) | -0,01 | -1,28 |
| CBOWN | 0,06 | 4,46 (**) | 0,03 | 10,30 (**) | -0,05 | -5,43 (**) | 0,01 | 1,28 | 0,10 | 6,87 (**) | 0,03 | 5,92 (**) |
| Technical Complexity | | | | | | | | | | | | |
| INVENT | 0,06 | 26,17 (**) | 0,01 | 15,49 (**) | 0,05 | 22,75 (**) | 0,02 | 13,18 (**) | 0,01 | 4,84 (**) | 0,02 | 26,43 (**) |
| IPC8 | 0,12 | 42,25 (**) | 0,01 | 20,60 (**) | 0,03 | 13,10 (**) | 0,02 | 7,21 (**) | -0,01 | -2,93 (**) | 0,03 | 29,00 (**) |
| BPC | 0,03 | 24,16 (**) | 0,00 | -6,31 (**) | -0,01 | -11,31 (**) | 0,00 | 3,98 (**) | 0,04 | 26,58 (**) | 0,01 | 10,73 (**) |
| NPC | 0,01 | 6,03 (**) | 0,00 | 2,61 (**) | 0,03 | 14,11 (**) | 0,03 | 15,99 (**) | 0,03 | 12,37 (**) | 0,01 | 10,98 (**) |
| EPO Joint Clusters (Reference = Industrial Chemistry) | | | | | | | | | | | | |
| JC-02 - Organic Chemistry | 0,18 | 14,24 (**) | 0,27 | 89,39 (**) | 0,22 | 19,86 (**) | 0,15 | 14,81 (**) | 0,04 | 2,51 (*) | 0,26 | 48,67 (**) |
| JC-03 - Polymers | 0,26 | 21,40 (**) | 0,07 | 24,76 (**) | 0,14 | 12,99 (**) | 0,12 | 13,54 (**) | 0,19 | 14,35 (**) | 0,15 | 30,06 (**) |
| JC-04 - Biotechnology | 0,49 | 35,92 (**) | 0,27 | 85,42 (**) | 0,07 | 5,86 (**) | 0,31 | 29,05 (**) | 0,03 | 1,85 | 0,29 | 51,36 (**) |
| JC-05 - Telecommunications | 0,58 | 29,47 (**) | -0,02 | -4,44 (**) | -0,10 | -5,55 (**) | 0,31 | 19,38 (**) | -0,28 | -8,85 (**) | 0,13 | 14,52 (**) |
| JC-06 - Audio/Video/Media | 0,21 | 11,78 (**) | -0,17 | -33,52 (**) | 0,21 | 13,30 (**) | 0,26 | 19,90 (**) | -0,23 | -9,34 (**) | -0,03 | -4,10 (**) |
| JC-07 - Electronics | -0,03 | -2,28 (*) | -0,14 | -36,22 (**) | 0,09 | 7,63 (**) | 0,14 | 13,91 (**) | -0,17 | -9,08 (**) | -0,07 | -11,91 (**) |
| JC-08 - Electricity | -0,16 | -11,36 (**) | -0,14 | -42,14 (**) | -0,03 | -2,46 (*) | -0,06 | -6,75 (**) | -0,14 | -8,56 (**) | -0,14 | -25,03 (**) |
| JC-09 - Computers | 0,16 | 7,46 (**) | -0,17 | -28,58 (**) | -0,04 | -2,14 (*) | 0,16 | 10,67 (**) | -0,15 | -5,21 (**) | -0,09 | -10,26 (**) |
| JC-10 - Measuring Optics | -0,24 | -16,61 (**) | -0,20 | -56,73 (**) | 0,07 | 6,12 (**) | -0,03 | -2,69 (**) | -0,24 | -13,84 (**) | -0,16 | -28,52 (**) |
| JC-11 - Handling & Processing | -0,34 | -25,16 (**) | 0,00 | 1,26 | -0,12 | -12,45 (**) | -0,08 | -9,08 (**) | 0,03 | 2,32 (*) | -0,06 | -12,12 (**) |
| JC-12 - Vehicles | -0,27 | -17,81 (**) | -0,16 | -45,75 (**) | -0,17 | -17,15 (**) | -0,07 | -7,30 (**) | -0,13 | -8,24 (**) | -0,25 | -42,33 (**) |
| JC-13 - Civil Engineering | -0,38 | -22,88 (**) | -0,07 | -18,47 (**) | -0,37 | -34,13 (**) | -0,18 | -17,63 (**) | -0,05 | -2,91 (**) | -0,21 | -33,41 (**) |
| JC-14 - Human Necessities | 0,12 | 9,49 (**) | -0,01 | -2,38 (*) | -0,11 | -11,35 (**) | 0,03 | 2,92 (**) | 0,00 | 0,33 | 0,01 | 1,54 |
| Country of residence of applicants (Reference = France) | | | | | | | | | | | | |
| AT | -0,06 | -1,34 | 0,06 | 7,25 (**) | -0,33 | -12,11 (**) | 0,03 | 1,18 | 0,10 | 2,49 (*) | 0,04 | 2,50 (*) |
| AU | 0,15 | 2,78 (**) | -0,09 | -6,85 (**) | 0,31 | 7,68 (**) | 0,50 | 12,61 (**) | -0,30 | -4,71 (**) | 0,00 | 0,05 |
| BE | 0,12 | 2,91 (**) | 0,00 | -0,43 | 0,18 | 6,36 (**) | 0,30 | 10,66 (**) | -0,02 | -0,45 | 0,09 | 5,82 (**) |
| CA | 0,28 | 7,15 (**) | -0,15 | -15,68 (**) | 0,26 | 8,48 (**) | 0,38 | 12,74 (**) | -0,16 | -3,24 (**) | -0,02 | -0,91 |
| CH | 0,10 | 3,85 (**) | 0,10 | 21,06 (**) | 0,31 | 18,26 (**) | 0,34 | 20,82 (**) | 0,03 | 1,17 | 0,25 | 27,44 (**) |
| DE | 0,02 | 1,35 | 0,03 | 10,53 (**) | -0,25 | -23,92 (**) | 0,16 | 15,10 (**) | 0,17 | 10,69 (**) | 0,05 | 7,92 (**) |
| DK | 0,22 | 4,65 (**) | 0,02 | 1,66 | -0,11 | -3,14 (**) | 0,39 | 11,56 (**) | 0,22 | 4,77 (**) | 0,09 | 4,83 (**) |
| ES | -0,30 | -3,63 (**) | 0,07 | 4,88 (**) | -0,23 | -4,79 (**) | 0,35 | 7,78 (**) | -0,14 | -1,91 | -0,03 | -1,20 |
| FI | 0,33 | 8,19 (**) | 0,01 | 0,75 | 0,13 | 4,38 (**) | 0,60 | 20,46 (**) | 0,16 | 3,72 (**) | 0,20 | 12,28 (**) |
| GB | 0,22 | 10,65 (**) | -0,08 | -17,56 (**) | 0,10 | 6,53 (**) | 0,20 | 13,72 (**) | 0,04 | 1,83 | -0,02 | -2,34 (*) |
| IL | 0,39 | 5,93 (**) | -0,05 | -3,25 (**) | 0,21 | 4,08 (**) | 0,30 | 5,77 (**) | -0,02 | -0,31 | 0,05 | 1,69 |
| IT | -0,05 | -1,82 | 0,02 | 3,21 (**) | -0,19 | -11,02 (**) | 0,46 | 27,30 (**) | -0,03 | -1,24 | -0,06 | -5,51 (**) |
| JP | 0,17 | 10,48 (**) | -0,46 | -123,43 (**) | 1,07 | 89,36 (**) | 0,44 | 40,97 (**) | -0,24 | -13,46 (**) | -0,10 | -16,27 (**) |
| KR | -0,11 | -1,54 | -0,41 | -22,38 (**) | 0,57 | 11,50 (**) | 0,51 | 11,11 (**) | -0,21 | -2,48 (*) | -0,20 | -7,11 (**) |
| NL | 0,08 | 3,49 (**) | 0,01 | 1,36 | 0,17 | 10,04 (**) | 0,42 | 26,02 (**) | 0,22 | 9,25 (**) | 0,12 | 12,63 (**) |
| SE | 0,16 | 5,19 (**) | -0,03 | -4,14 (**) | 0,51 | 23,06 (**) | 0,51 | 24,15 (**) | 0,12 | 3,70 (**) | 0,16 | 13,13 (**) |
| US | 0,40 | 26,73 (**) | -0,16 | -48,94 (**) | 0,58 | 53,09 (**) | 0,48 | 43,61 (**) | -0,10 | -6,40 (**) | 0,05 | 8,45 (**) |
| RoW | 0,02 | 0,63 | -0,01 | -1,37 | 0,10 | 4,69 (**) | 0,19 | 8,42 (**) | -0,22 | -5,93 (**) | 0,00 | 0,09 |
| Time dummies (Reference = 1990) | | | | | | | | | | | | |
| 1991 | 0,04 | 3,15 (**) | -0,03 | -10,18 (**) | -0,02 | -1,92 | 0,02 | 1,99 (*) | 0,01 | 0,51 | -0,03 | -6,55 (**) |
| 1992 | 0,09 | 6,88 (**) | -0,02 | -6,65 (**) | -0,02 | -1,85 | 0,04 | 4,32 (**) | -0,02 | -1,25 | -0,06 | -10,74 (**) |
| 1993 | 0,15 | 11,38 (**) | -0,03 | -8,42 (**) | -0,06 | -6,34 (**) | 0,01 | 1,39 | -0,06 | -4,10 (**) | -0,09 | -16,83 (**) |
| 1994 | 0,21 | 15,81 (**) | -0,04 | -11,87 (**) | -0,08 | -7,48 (**) | 0,00 | 0,00 | -0,08 | -5,39 (**) | -0,10 | -18,55 (**) |
| 1995 | 0,22 | 16,15 (**) | -0,07 | -21,82 (**) | -0,07 | -7,15 (**) | -0,02 | -1,91 | -0,13 | -8,91 (**) | -0,13 | -24,64 (**) |
| Model | | | | | | | | | | | | |
| # Observations | 242048 | | 239528 | | 242048 | | 239636 | | 242048 | | 242048 | |
| Pseudo R ² | 0,05 | | 0,10 | | 0,20 | | 0,05 | | 0,04 | | 0,04 | |
| Log likelihood | -229590 | | -584809 | | -124665 | | -157567 | | -52387 | | -539708 | |
| LR ch ² (P>ch ²) | 25606,3 (0,00) | | 124439,48 (0,00) | | 61 020 (0,00) | | 16 911 (0,00) | | 4 681 (0,00) | | 40122 (0,00) | |
| LR Test of alpha=0 (P>chibar ²) | 42000 (0,00) | | | | | | | | | | 51000 (0,00) | |

Source: Own calculations based on EPO data – Patents filed 1990-1995
Coefficients significant at the 5% probability level (*) or at the 1% probability level (**)

The dummy variables identifying divisional strategies provide very interesting results as well. The *HASDIV* variable is one of the very few variables associated with a highly significant positive coefficient with all 6 indicators. That is, parents of divisional filings are significantly associated with more important patents, no matter the way value is measured: they are more likely to receive citations, to be validated in more countries, to be applied in the trilateral offices, to be maintained 10 years at least and to be opposed. However, the *ISDIV* variable, identifying divisional filings themselves, presents similar results though with smaller significance levels on oppositions and families and a negative coefficient on citations received. That they tend to survive longer may be a mere consequence of a longer application and examination process. It is in the very nature of divisionals to be associated with longer pendency times as discussed here above; hence the likelihood for them to be still active at the end of their tenth year from filing is systematically higher. Similarly, if the parents are triadic, then the children will necessarily be considered triadic as well since triadic families are built on priority numbers. But the fact that they are less significantly associated with large EPC families and high opposition rates than their parents, and more importantly their negative coefficient on citations received suggest that most value of divisional applications remains within the original application. This could explain why the parents are more likely to be cited, opposed, and validated in more countries. With other words, it is likely that applicants making use of divisionals tend to keep the core or essence of their invention defined in the root application and spread surrounding inventions or secure fall back positions into divisionals.

Confirming a well known result, the PCT option is also associated with higher value. The *PCT* variable is particularly well performing in predicting the size of the family or the likelihood to be triadic, which is in both cases a highly expected result given the very objective of the Patent Cooperation Treaty to simplify the extension of domestic patents abroad. It is therefore no surprise at all that patent applications filed in the three major offices (JPO, USPTO and EPO) or extended in many European Countries, given their international promise, were filed through the PCT route. PCT filings being associated in addition with more forward citations and a higher likelihood to be maintained for ten years confirms earlier evidences that the PCT route drives more valuable patent applications (Guellec and van Pottelsberghe, 2000, 2002; Graham et al., 2002; Reitzig, 2004a). Nonetheless, these results are counterbalanced by the fact that the *PCT* variable has no effect on the likelihood to receive an opposition, which is consistent with Harhoff and Hall (2002), Harhoff and Reitzig (2004), Reitzig (2004b) and Wagner (2004).

Finally, the request for accelerated search is associated with a positive and significant coefficient with all 6 indicators. This result is in contradiction with earlier empirical evidence (Graham et al., 2002; Jerak and Wagner, 2003; Reitzig, 2004a), though the *ACCSRC* variable had only been tested as a determinant of oppositions. However, the same authors as well as Harhoff and Hall (2002) found positive and significant coefficients for accelerated *examination* requests. Our results support the idea that the strategy consisting in getting the patent granted faster is also associated with patents of higher value and that this effect prevails.

Complexity

The set of variables expressing the technical complexity of patents are also associated with many significant coefficients. Most of them are consistent with the literature. The number of inventors is associated with strong positive coefficients on all indicators (in line with Reitzig, 2004b), as is the case for non patent references (in line with Carpenter et al. (1980) and Narin et al. (1987)), but in contradiction with Reitzig (2004b) who obtained a negative coefficient, and Allison and Lemley (1998), Harhoff and Hall (2002), Harhoff et al. (2002), Harhoff and Reitzig (2004), and Wagner (2004) who all obtained non-significant correlations).

The number of IPC classes (a measure of the technological scope according to Lerner (1994)) gets similar coefficients, except it is associated with a slightly smaller probability for the patent to be opposed. The same variable was associated with a negative coefficient in Guellec and van Pottelsberghe (2000, 2002) as well as Harhoff and Reitzig (2004), and a non significant or ambiguous parameter in Lanjouw and Schankerman (1997, 2001), Harhoff et al. (2002), Reitzig (2004a) and Schneider (2006). One of the most frequently tested determinant, backward patent citations have been found positively correlated in 13 empirical pieces of research listed in Table A1 in the appendix and 9 times non significant, but negative in only one case, on the probability for a patent to get granted (Schneider, 2006). In the present estimations, backward patent citations counts are associated with more citations and a higher likelihood to be maintained 10 years or opposed, but also with smaller EP families and a smaller likelihood to be triadic, making it one of the most instable variables across indicators.

Patent ownership

The three variables identifying different types of applicants bring some additional light on these results. Two preliminary observations may be made when looking at the *CUMUL* and *OCCAS* variables, expressing the experience or lack of experience of applicants in terms of their cumulative portfolio of patent applications at the EPO: first that the sign of their coefficient varies widely from indicator to indicator, and second that they are usually in opposition with each other: the coefficient of these two variables (*CUMUL* and *OCCAS* respectively) is non significant vs. negative on citations, negative vs. positive on EPC family size and opposition likelihood, then positive vs. negative on likelihood to be triadic and maintained for 10 years. These puzzling results – in line with the literature – may be interpreted as follows.²² As compared to large applicants, inexperienced patentees are less likely to get their patents cited, to build triadic patent families and to maintain their patents for 10 years or more, but they tend to validate their patents in more European countries and are more likely to see their patents opposed.²³ To the contrary, academic patents are associated with slightly more forward citations, but slightly lower probabilities to be triadic, maintained for 10 years or opposed.²⁴ Finally, the dummy variable identifying cross-border applications (*CBOWN*) is associated with more citations, larger EPC families and more frequent oppositions, but also with a smaller likelihood to be triadic and no particular survival rates.²⁵

Country and industry effects

When looking at country and industry dummies, the most striking observation is that there seem to be very significant geographical and industrial effects, and that the coefficients are highly variable from one indicator to the other – even more so with countries than industrial sectors. In terms of industries, the most significant parameters are to be found with the chemical and biotechnology clusters. The coefficients associated with the respective dummy variables are always positive and highly significant, except with biotechnologies having no effect on oppositions. In particular, organic chemistry and biotechs are associated with the most significant variables of the model in explaining the European family size, that is patent families seem significantly larger in these clusters than in others. The roots of this result are probably to be found in market structures, competitive processes and the importance of R&D in these sectors.

²² The portfolio size has been found 2 times non significant, 4 times positive and 6 times negative on 5 different indicators throughout the literature listed in Table A1 in the appendix.

²³ Allison et al. (2003) found a positive correlation of a similar measure of inexperience with a probability of litigation.

²⁴ Gambardella et al. (2006) found a negative correlation of academic patentees with the surveyed monetary value of patents and Harhoff and Hall (2002) found no effect of the same variable on the probability of opposition.

²⁵ Guellec and van Pottelsberghe (2000, 2002) found the same variable positively correlated with the probability to get granted.

Four sectors seem to be characterized by more forward citations on average: organic chemistry, polymers, biotechnologies and telecommunications, which may be due to inventions being more frequently incremental in these areas (hence patent applications are more frequently or more intensively relying on the state of the art), or to the state of the art being more easily identifiable in these fields, possibly thanks to a higher degree of codification and standardization in the description of inventions. Triadic families and oppositions also look more frequent in pretty much the same areas, but patents are also more frequently triadic in the multimedia industry. The industries experiencing the longest survival rates are biotechnologies, multimedia and telecommunications, and oppositions look also more frequent in the automotive industry, an industry otherwise associated with lower value patents. At the lower end of the ranking, handling and processing, automotive, civil engineering, electricity and measuring optics sectors are associated with significant negative coefficients on almost all indicators, especially citations, triadic and survival rates. In particular, the measuring optics cluster is associated with the smallest family sizes and lowest opposition rates.

These large discrepancies across industries are also observable across countries of applicants, but indicator to indicator variations are even more perceptible. The most remarkable countries are also the largest patent filers at the EPO: the United States, Japan and Germany, all with very striking fluctuations across indicators. Japanese and US patents are logically the most triadic ones (for two-thirds the way to a triadic family is done when a Japanese or US patent is filed at the EPO) along with patents from Nordic European countries. US and Japanese patents are also the most frequently cited (along with British ones) and experience the highest survival rates (together with Italian ones). But they are associated with the smallest EPC families and the lowest opposition rates. This might suggest that patents from Japan or the US extended to and granted by the EPO are of higher value on average, but that patentees from these two countries are more selective in choosing the States where they would like their inventions to be protected (supposedly they target the most relevant European countries to their business, usually the three largest according to van Pottelsberghe and van Zeebroeck (2008)) and produce patents that are less likely to be opposed. This might be an indication of lower value, but it may also very well be that having successfully passed the granting process in one or two major triadic offices and having crossed at least one ocean to reach the EPO, these patents are more robust and less likely to be successfully challenged in oppositions. Conversely, German patents are characterized on average by the largest EPC families (along with their Austrian and Swiss counterparts) and exposed to the highest risk of being opposed (together with Danish and Dutch patents), but they are the least likely to be triadic and among the least cited.

It is very likely that these discrepancies across countries are to a large extent related with home disadvantage biases. Being a European applicant, one is more likely to file a patent at the EPO as this is the first natural step for any European patentee willing to seek protection beyond one's domestic borders.²⁶ But since a European applicant could be less selective in which patents to extend to the EPO, the average value of his EPO filings might be lower than that of Japanese or US applicants who had to make a more difficult decision to cross the ocean or not and were then probably more selective.

In addition to these results, it may be observed that coefficients associated with time dummies suggest a negative trend with all indicators (hereby suggesting a significant decline in patent value over the period 1990-1995) except with the number of forward citations received which seems to have continuously increased over the same period. This is consistent with conjectures on a declining trend in patent quality made by Jaffe and Lerner (2004) and Guellec and van Pottelsberghe (2007),

²⁶ This is the classical argument of the well-known home advantage bias (van Zeebroeck et al., 2006b).

as well as with statistical evidence reported by van Zeebroeck (2007) and van Pottelsberghe and van Zeebroeck (2008).

Finally, note that the regression on the composite value indicator provides excellent aggregate effects that may be used to summarize the correlation of each explanatory variable with the different indicators of patent value into one aggregate coefficient. Therefore, in the remaining of this section, we will focus on regression coefficients on the composite value indicator.

On the consistency of the results

For the sake of robustness, several additional specifications of the model have been tested, which confirm the robustness of our specification.²⁷ In addition, it appeared highly valuable to check for a sensitivity of the results to the sample used in the regression, (i.e. to investigate potential country or industry specific effects). To do so, the main model presented in Table 7 has been run for each of the six value indicators on 14 industry samples and 18 country samples. For each indicator, the number of times each explanatory variable got a positive (+), negative (-), or non-significant (/) estimated coefficient was then computed and reported in Table A3 for the 14 industry regressions and Table A4 for the 18 country regressions. Both tables are found in the appendix.

By looking at each indicator in isolation (in Table A3), one can easily assess the stability of the explanatory power of each variable on the value indicator considered. When explaining the number of citations received, five parameters appear as perfectly stable (and positive): *CLMDEV*, *PRIO*, *INVENT*, *IPC8*, and *BPC*. A few additional variables are fairly stable but lost their significance in a few (less than half of) sectors: *CLMLS* (-), *HASDIV* (+), *ISDIV* (-), *PCT* (+), *NPC* (+). The latter variable, *NPC*, even turned significantly negative in one case (polymers). Finally, some variables lose their significance in a majority of industries: *ACCSRC* (+), *OCCAS* (-), *ACAD* (+), and *CBOWN* (+). With EPC family sizes as the dependent variable, only parents of divisionals (*HASDIV*) and the PCT route are perfectly stable (and positively significant). *CLMDEV* (+), *CLMLS* (-), *IPC8* (+) and *OCCAS* (+) lost their significance in 2 or 3 sectors, whereas the latter variable even turned negative in 2 cases. All other variables appear much less stable.

The results of the triadic estimations look slightly more stable than with the two previous indicators: *CLMDEV* (+), *PRIO* (+), *EQUIV* (+), *ISDIV* (+), *PCT* (+), *CUMUL* (+), and *OCCAS* (-) are close to perfectly insensitive to the industrial sector chosen. *HASDIV* (+), *INVENT* (+), *BPC* (-), and *NPC* (+) kept the significance and sign of their coefficient across 11 or 12 industries out of 14. The stability of the estimates across sectors differs again slightly when the dependent variable is the likelihood to be maintained 10 years. Indeed, only six variables were associated with fairly to perfectly stable coefficients: *CLMDEV* (+), *HASDIV* (+), *ISDIV* (+), *OCCAS* (-), *INVENT* (+), and *NPC* (+). The most sensitive results were obtained with the opposition regression, where only the number of backward patent references (*BPC*) kept a significant and positive sign throughout the industries. To a lesser extent, *HASDIV* (+), *CUMUL* (-), and *OCCAS* (+) are associated with fairly stable coefficients. All other variables lost their significance entirely in a majority of the sectors.

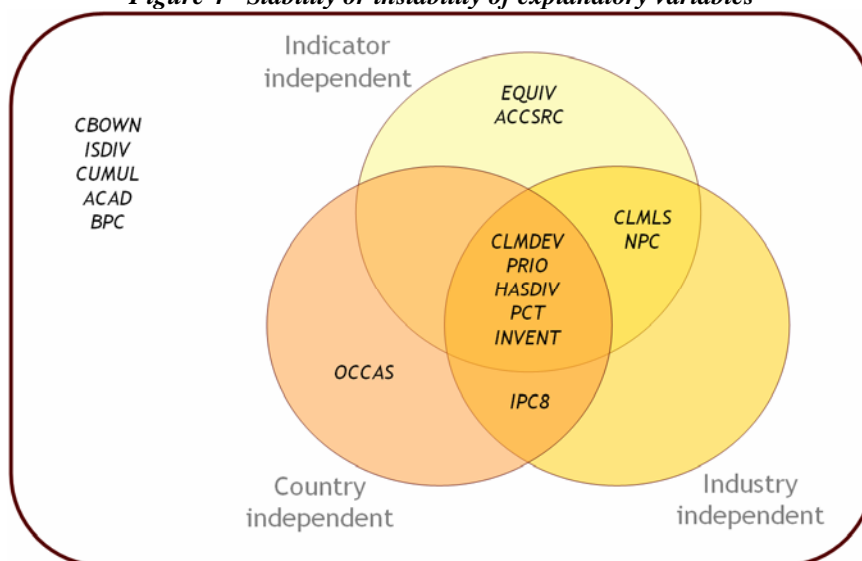
When looking at the overall stability as measured with the regression on the composite value, six variables appear (almost) perfectly stable (and all significantly positive): *CLMDEV*, *PRIO*, *HASDIV*, *PCT*, *INVENT*, *IPC8*. Four additional ones kept their sign across industries but sometimes lost their significance level: *CLMLS* (-), *EQUIV* (+), *ISDIV* (+), and *CUMUL* (-). All other variables either lost their significance in a majority of the cases, or changed in sign in some industries.

²⁷ The results of these robustness estimates are available upon request.

The same exercise conducted with 18 country-per-country regressions for each indicator (reporter in Table A4) leads to a similar conclusions of high dependence of many determinants to the sample chosen. With the number of forward citations received as a dependent variable, only four variables preserved their significativity and positive sign in at least two-third of the countries: *CLMDEV*, *INVENT*, *IPC8*, and *BPC*. Although less stable, *PRIO* and *HASDIV* both remained significant and positive in a small majority of the cases. When the EPC family size is regressed, the sensibility to the country is even stronger, with only three variables (*HASDIV* (+), *PCT* (+) and *CUMUL* (-)) constant in sign and significativity in a majority of the estimations. Here again, the results are much better when the dependent variable is the triadic nature of patents. Seven variables are here strongly stable: *CLMDEV*, *PRIO*, *EQUIV*, *ISDIV*, *PCT*, *CUMUL* and *OCCAS*, the latter being the only one associated with a negative coefficient. With the likelihood to survive 10 years, the sensibility to the sample rises again with four variables only being stable in a small majority of the cases: *HASDIV* (+), *ISDIV* (+), *OCCAS* (-), and *NPC* (+). The results are no better with the opposition regression as *HASDIV* (+), *CUMUL* (-), *BPC* (+), and *NPC* (+) are the only variables to be stable in a majority of the regressions. These high sensibilities translate with the composite value indicator regressions into a very small set of robust (and positive) coefficients: *CLMDEV*, *HASDIV*, *PCT*, *INVENT* and *IPC8*. Albeit slightly less stable, the *OCCAS* variable remains negative and significant in two thirds of the regressions.

All these results have highlighted a number of country and industry dependencies in the correlation between filing strategies and technical characteristics of patents and 6 different value indicators. These sensibilities are summarised in Figure 4. In order to dichotomise the robustness or sensitivity of each variable with respect to the indicator, country or industry used, we define the following thresholds: a variable is considered robust (independent) with respect to one dimension if its coefficient kept the same sign in all regressions across this dimension and remained significant at the 5% probability level in at least two thirds of the regressions. This means no more than 2 non-significant parameters in the six indicators regressions (from Table 7), maximum 4 in industry regressions on the composite indicator (from the sixth column in Table A3) and 6 in country regressions on the composite indicator (from the sixth column in Table A4).

Figure 4 - Stability or instability of explanatory variables



From Figure 4, it appears that only 5 variables would pass this independence test: excess claims, priorities, parents of divisionals, the PCT route and the number of inventors. Five variables appear

as sensitive to the three dimensions: cross-border ownership, divisionals, applicant's portfolio, academic patentees and the number of backward patent references.

6. Concluding remarks

The surge in the size of applications is associated with the exploitation of all procedural possibilities offered by patent systems to build the most suitable filing strategy (van Zeebroeck et al., 2006; Stevnsborg and van Pottelsberghe, 2007). The present paper empirically establishes that these filing strategies consisting in drafting excessively long patents – often by assembly or disassembly – and in particular the filing of divisional applications, are indicative of more important patents.²⁸

The benefits of such divisional or construction strategies to patent holders, resulting in a set of patents covering a single invention, are guessable: they increase the cost of opposition for competitors and may induce complexity and uncertainty on the relevant market. However, according to Harhoff (2006), such strategies may more likely be an endogenous response to value: because a knowledge asset is more valuable, a patentee would assemble bundles of patents to protect it, that is, the owner will strengthen the legal protection of the invention by creating a web of partly overlapping patents whose overall structure may be more robust than a single patent could be.

Although the factual or empirical evidence in this matter is very scarce, the risk is high that such strategies could derive to real abuses of the patent system (see Stevnsborg and van Pottelsberghe, 2007). For instance, by re-filing the same subject-matter again and again by means of divisionals over several generations, a patentee could unduly keep alive some subject-matter from a parent application that had been refused for grant by the Office. By filing divisionals of the application, embedding the valuable subject matter, and then divisionals of divisionals, and so on for up to twenty years, such a strategy could provide the applicant with a provisional protection as provided by Article 67 EPC²⁹ over some subject-matter which had already been judged unpatentable by the Office. In a recent ruling,³⁰ the EPO Enlarged Board of Appeal confirmed that this strategy is a legitimate exploitation of the procedural possibilities afforded by the EPC as it is, although some consider it “*an abuse in relation to the law as they think it ought to be [...]*.” The Board nonetheless acknowledged that it is “*unsatisfactory that sequences of divisional applications each containing the same broad disclosures of the original patent application [i.e. with the same description] should be pending for up to twenty years.*” But the Board decided that “*it would be for the legislator to consider where there are abuses and what the remedy could be.*”³¹

By means of a comprehensive sample containing a large number of variables over the full cohort of patents granted by the EPO and filed between 1990 and 1995, this paper significantly contributes to the understanding of patent filing strategies and demonstrates their association with patent value. These results confirm that developments in patent filing strategies are something policy makers and all stakeholders of the patent system at large should care about for they signal more important patents that will become unavoidable in the state of the art (they are more frequently cited), remain active for longer in more countries (they have higher survival rates and larger family sizes), and tend to be more frequently opposed (clearly witnessing economic value on the relevant market).

²⁸ One limitation of the present research is that it relies only on patents granted. As a consequence, from all applications filed using some of the strategies discussed here, only those that successfully went through the examination procedure are accounted for and are found to be more valuable than others. It remains therefore possible that these strategies are in fact associated with below average grant rates, suggesting that they actually carry many applications of dubious value.

²⁹ According to Article 67 EPC, a pending application provisionally confers upon the applicant the same rights in all designated States as if the patent was granted (see van Zeebroeck, 2007).

³⁰ Cases G0001/05 and G0001/06, decided on June 28th, 2007. The full transcription of the decision is available on the EPOLINE website.

³¹ EPO EBA Decision in case G0001/05 rendered on June 28, 2007, pp. 44-45.

The exceptional size and richness of the dataset constructed for this study also made it possible to test at a larger scale the association between many classical determinants of patent value and different established indicators of patent value. This exercise does confirm some existing empirical evidence: the number of claims, the PCT procedure, and the number of inventors are significantly and consistently indicative of higher value patents, so are two new determinants proposed in this paper: the number of priorities and whether a patent is the parent of divisional filings. But this paper also clearly demonstrates that most of the existing estimates are actually highly sensitive to the sampling and/or the dependent variable used. In particular, well established indicators of patent value such as backward patent citations and the applicant's patent portfolio size appeared to have a very ambiguous relationship with patent value, which heavily depends upon the country from which patents originate, the technology area they are related to, and the value indicator chosen.

This sensitivity of many determinants to the dependent variable used as indicator patent value confirms the results of an earlier paper (van Zeebroeck, 2007), which showed that the different indicators actually capture different dimensions of the value and hence may have different drivers, calling for the construction of a composite measure of value that would encapsulate the different dimensions into one indicator. Adding to it the dependence of most results to the country or the industry as presented in this paper, these results further suggest that most empirical evidence on the indicators of patent value should be generalized with much care.

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Appendixes

Table A1 – Codes used to refer to the state of the art on patent value in the tables

| Code | Short Reference | Code | Short Reference | Code | Short Reference |
|-------------|---------------------------------|-------------|--------------------------------------|-------------|--|
| AANM91 | Albert et al. (1991) | GVP00 | Guellec and van Pottelsberghe (2000) | P86 | Pakes (1986) |
| AL98 | Allison and Lemley (1998) | GVP02 | Guellec and van Pottelsberghe (2002) | PS84 | Pakes and Schankerman (1984) |
| ALMT03 | Allison et al. (2003) | HC03 | Hagedoorn and Cloudt (2003) | PS89 | Pakes and Simpson (1989) |
| ACC04 | Arora et al. (2004) | H99 | Hall (1999) | PJW05 | Palangkaraya et al. (2005) |
| A93 | Austin (1993) | HH04 | Hall and Harhoff (2004) | P03 | Palomeras (2003) |
| B06 | Bessen (2006) | HMG06 | Hall and MacGarvie (2006) | P96 | Putnam (1996) |
| B05 | Betran (2005) | HJT01 | Hall et al. (2001) | R02 | Reitzig (2002) |
| BCM07 | Blind et al. (2007) | HGHM03 | Hall et al. (2003) | R03 | Reitzig (2003) |
| BVR02 | Bloom and van Reenen (2002) | HJT05 | Hall et al. (2005) | R04a | Reitzig (2004a) |
| BR01 | Bosworth and Rogers (2001) | HH02 | Harhoff and Hall (2002) | R04b | Reitzig (2004b) |
| PATVAL06 | Brusoni et al. (2006) | HR04 | Harhoff and Reitzig (2004) | SVP07 | Sapsalis and van Pottelsberghe (2007) |
| CS04 | Calderini and Scellato (2004) | HNSV99 | Harhoff et al. (1999) | SVPN06 | Sapsalis et al. (2006) |
| CN79 | Campbell and Nieves (1979) | HSV02 | Harhoff et al. (2002) | S98 | Schankerman (1998) |
| CN83 | Carpenter and Narin (1983) | HSV03 | Harhoff et al. (2003) | SP86 | Schankerman and Pakes (1986) |
| CC80 | Carpenter et al. (1980) | HWW05 | Hunter et al. (2005) | S65 | Scherer (1965) |
| CNW81 | Carpenter et al. (1981) | JTF00 | Jaffe et al. (2000) | SH00 | Scherer and Harhoff (2000) |
| CG88 | Cockburn and Griliches (1988) | JW03 | Jerak and Wagner (2003) | SHK00 | Scherer et al. (2000) |
| CS99 | Cornelli and Schankerman (1999) | KT86 | Kamien and Tauman (1986) | S06 | Schneider (2006) |
| C04 | Cremers (2004) | KVMB02 | Kleinknecht et al. (2002) | S07 | Schneider (2007) |
| CDK96 | Crépon et al. (1996) | K90 | Klemperer (1990) | S99 | Scotchmer (1999) |
| CHO05 | Czarnitzki et al. (2005) | KL99 | Kortum and Lerner (1999) | SG90 | Scotchmer and Green (1990) |
| D05 | Deng (2005) | K98 | Kremer (1998) | S05 | Serrano (2005) |
| DG61 | Dernburg and Gharrity (1961) | L93 | Lanjouw (1993) | S01 | Shane (2001) |
| DI97 | Duguet and lung (1997) | L98 | Lanjouw (1998) | SK97 | Shane and Klock (1997) |
| G92 | Gallini(1992) | LS97 | Lanjouw and Schankerman (1997) | ST04 | Sherry and Teece (2004) |
| G05 | Gambardella (2005) | LS99 | Lanjouw and Schankerman (1999) | SV04 | Silverberg and Verspagen (2004) |
| GHV06 | Gambardella et al. (2006) | LS01 | Lanjouw and Schankerman (2001) | S94 | Sullivan (1994) |
| GS90 | Gilbert and Shapiro (1990) | LS04 | Lanjouw and Schankerman (2004) | T86 | Teece (1986) |
| GHHM02 | Graham et al. (2002) | LPP98 | Lanjouw et al. (1998) | T06 | Teece (2006) |
| GS95 | Greene and Scotchmer (1995) | L94 | Lerner (1994) | TF94 | Tong and Frame (1994) |
| GR06 | Greenhalgh and Rogers (2006) | MN90 | Merges and Nelson (1990) | T90 | Trajtenberg (1990) |
| GR07 | Greenhalgh and Rogers (2007) | MT05 | Meyer and Tang (2005) | VBVZ08 | van Pottelsberghe and van Zeebroeck (2008) |
| GJW05 | Griffiths et al. (2005) | N04 | Nagaoka (2004) | VZ07 | van Zeebroeck (2007) |
| G81 | Griliches (1981) | NNP87 | Narin et al. (1987) | W04 | Wagner (2004) |
| G89 | Griliches (1989) | NS06 | Noel and Schankerman (2006) | WPJ07 | Webster et al. (2007) |
| GPH86 | Griliches et al. (1986) | ODST98 | O'Donoghue et al. (1998) | | |

Table A2 – Summary Statistics of classical determinants and control variables

| Variable | Obs | Mean | StDev | Min | Max |
|--|--------|------|-------|------|------|
| Applicant Profiles | | | | | |
| CUMUL (/1000) | 248856 | 0,41 | 0,88 | 0,00 | 4,83 |
| OCCAS | 248856 | 0,21 | 0,41 | 0 | 1 |
| ACAD | 248855 | 0,02 | 0,13 | 0 | 1 |
| CBOWN | 248856 | 0,10 | 0,29 | 0 | 1 |
| Technological complexity | | | | | |
| INVENT | 248856 | 2,40 | 1,71 | 1 | 32 |
| IPC8 | 248532 | 1,93 | 1,29 | 1 | 43 |
| BPC | 245961 | 4,48 | 2,88 | 0 | 99 |
| NPC | 245963 | 0,99 | 1,79 | 0 | 61 |
| EPO Joint Clusters | | | | | |
| JC-01 - Industrial Chemistry | 248856 | 0,12 | 0,33 | 0 | 1 |
| JC-02 - Organic Chemistry | 248856 | 0,13 | 0,34 | 0 | 1 |
| JC-03 - Polymers | 248856 | 0,11 | 0,31 | 0 | 1 |
| JC-04 - Biotechnology | 248856 | 0,10 | 0,30 | 0 | 1 |
| JC-05 - Telecommunications | 248856 | 0,03 | 0,18 | 0 | 1 |
| JC-06 - Audio/Video/Media | 248856 | 0,05 | 0,22 | 0 | 1 |
| JC-07 - Electronics | 248856 | 0,08 | 0,27 | 0 | 1 |
| JC-08 - Electricity & Elec. Machines | 248856 | 0,11 | 0,32 | 0 | 1 |
| JC-09 - Computers | 248856 | 0,03 | 0,18 | 0 | 1 |
| JC-10 - Measuring Optics | 248856 | 0,09 | 0,29 | 0 | 1 |
| JC-11 - Handling & Processing | 248856 | 0,14 | 0,35 | 0 | 1 |
| JC-12 - Vehicles & Gen. Technology | 248856 | 0,10 | 0,30 | 0 | 1 |
| JC-13 - Civil Engineering / Thermodynamics | 248856 | 0,09 | 0,29 | 0 | 1 |
| JC-14 - Human Necessities | 248856 | 0,11 | 0,31 | 0 | 1 |
| Country of residence of applicant | | | | | |
| AT Applicant | 248856 | 0,01 | 0,10 | 0 | 1 |
| AU Applicant | 248856 | 0,00 | 0,07 | 0 | 1 |
| BE Applicant | 248856 | 0,01 | 0,10 | 0 | 1 |
| CA Applicant | 248856 | 0,01 | 0,09 | 0 | 1 |
| CH Applicant | 248856 | 0,04 | 0,19 | 0 | 1 |
| DE Applicant | 248856 | 0,20 | 0,40 | 0 | 1 |
| DK Applicant | 248856 | 0,01 | 0,08 | 0 | 1 |
| ES Applicant | 248856 | 0,00 | 0,06 | 0 | 1 |
| FI Applicant | 248856 | 0,01 | 0,09 | 0 | 1 |
| FR Applicant | 248856 | 0,09 | 0,28 | 0 | 1 |
| GB Applicant | 248856 | 0,05 | 0,22 | 0 | 1 |
| IL Applicant | 248856 | 0,00 | 0,05 | 0 | 1 |
| IT Applicant | 248856 | 0,03 | 0,18 | 0 | 1 |
| JP Applicant | 248856 | 0,22 | 0,41 | 0 | 1 |
| KR Applicant | 248856 | 0,00 | 0,06 | 0 | 1 |
| NL Applicant | 248856 | 0,04 | 0,19 | 0 | 1 |
| SE Applicant | 248856 | 0,02 | 0,14 | 0 | 1 |
| US Applicant | 248856 | 0,26 | 0,44 | 0 | 1 |
| Applicant from the ROW | 248856 | 0,02 | 0,13 | 0 | 1 |
| Year of filing | | | | | |
| 1990 | 248856 | 0,17 | 0,37 | 0 | 1 |
| 1991 | 248856 | 0,16 | 0,37 | 0 | 1 |
| 1992 | 248856 | 0,16 | 0,37 | 0 | 1 |
| 1993 | 248856 | 0,17 | 0,37 | 0 | 1 |
| 1994 | 248856 | 0,17 | 0,38 | 0 | 1 |
| 1995 | 248856 | 0,17 | 0,38 | 0 | 1 |

Table A3 – Industry dependencies in the main model (14 industry-specific regressions per value indicator)

| Variable | 5yrs Citations | | | EPC Family | | | Triadic | | | Survived 10yrs | | | Opposed | | | Composite | | | Total | | | TOT |
|----------|----------------|----|----|------------|----|----|---------|----|----|----------------|----|----|---------|----|----|-----------|----|----|-------|----|----|-----|
| | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | |
| CLMDEV | 0 | 0 | 14 | 3 | 0 | 11 | 0 | 0 | 14 | 2 | 0 | 12 | 8 | 1 | 5 | 0 | 0 | 14 | 13 | 1 | 70 | 84 |
| CLMLS | 6 | 8 | 0 | 3 | 11 | 0 | 6 | 8 | 0 | 11 | 3 | 0 | 10 | 2 | 2 | 3 | 11 | 0 | 39 | 43 | 2 | 84 |
| PRIO | 0 | 0 | 14 | 10 | 0 | 4 | 0 | 0 | 14 | 8 | 0 | 6 | 11 | 1 | 2 | 0 | 0 | 14 | 29 | 1 | 54 | 84 |
| EQUIV | 12 | 1 | 1 | 11 | 0 | 3 | 0 | 0 | 14 | 8 | 0 | 6 | 9 | 0 | 5 | 5 | 0 | 9 | 45 | 1 | 38 | 84 |
| HASDIV | 4 | 0 | 10 | 0 | 0 | 14 | 3 | 0 | 11 | 0 | 0 | 14 | 2 | 0 | 12 | 0 | 0 | 14 | 9 | 0 | 75 | 84 |
| ISDIV | 4 | 10 | 0 | 9 | 0 | 5 | 0 | 0 | 14 | 1 | 0 | 13 | 9 | 0 | 5 | 5 | 0 | 9 | 28 | 10 | 46 | 84 |
| PCT | 5 | 0 | 9 | 0 | 0 | 14 | 1 | 0 | 13 | 4 | 1 | 9 | 12 | 1 | 1 | 1 | 0 | 13 | 23 | 2 | 59 | 84 |
| ACCSRC | 9 | 1 | 4 | 12 | 0 | 2 | 12 | 0 | 2 | 8 | 0 | 6 | 9 | 0 | 5 | 11 | 0 | 3 | 61 | 1 | 22 | 84 |
| CUMUL | 9 | 2 | 3 | 0 | 14 | 0 | 0 | 0 | 14 | 4 | 3 | 7 | 3 | 11 | 0 | 5 | 9 | 0 | 21 | 39 | 24 | 84 |
| OCCAS | 4 | 6 | 4 | 1 | 2 | 11 | 0 | 14 | 0 | 1 | 13 | 0 | 3 | 1 | 10 | 3 | 8 | 3 | 12 | 44 | 28 | 84 |
| INVENT | 0 | 0 | 14 | 5 | 3 | 6 | 3 | 0 | 11 | 2 | 0 | 12 | 7 | 1 | 6 | 1 | 0 | 13 | 18 | 4 | 62 | 84 |
| IPC8 | 0 | 0 | 14 | 2 | 0 | 12 | 5 | 0 | 9 | 8 | 0 | 6 | 10 | 2 | 2 | 0 | 0 | 14 | 25 | 2 | 57 | 84 |
| BPC | 1 | 0 | 13 | 9 | 3 | 2 | 2 | 12 | 0 | 6 | 2 | 6 | 0 | 0 | 14 | 3 | 3 | 8 | 21 | 20 | 43 | 84 |
| NPC | 4 | 1 | 9 | 3 | 7 | 4 | 2 | 0 | 12 | 3 | 0 | 11 | 5 | 1 | 8 | 2 | 2 | 10 | 19 | 11 | 54 | 84 |
| CBOWN | 11 | 0 | 3 | 3 | 3 | 8 | 8 | 6 | 0 | 7 | 3 | 4 | 8 | 0 | 6 | 6 | 2 | 6 | 43 | 14 | 27 | 84 |
| ACAD | 9 | 0 | 5 | 7 | 3 | 4 | 9 | 5 | 0 | 9 | 5 | 0 | 11 | 3 | 0 | 11 | 2 | 1 | 56 | 18 | 10 | 84 |
| APP_AT | 11 | 1 | 2 | 6 | 1 | 7 | 4 | 10 | 0 | 6 | 3 | 5 | 12 | 0 | 2 | 6 | 2 | 6 | 45 | 17 | 22 | 84 |
| APP_AU | 13 | 0 | 1 | 7 | 6 | 1 | 6 | 1 | 7 | 3 | 0 | 11 | 9 | 4 | 0 | 6 | 4 | 4 | 44 | 15 | 24 | 83 |
| APP_BE | 13 | 0 | 1 | 8 | 2 | 4 | 8 | 1 | 5 | 4 | 0 | 10 | 7 | 3 | 3 | 4 | 2 | 8 | 44 | 8 | 31 | 83 |
| APP_CA | 9 | 0 | 5 | 5 | 9 | 0 | 6 | 0 | 8 | 4 | 0 | 10 | 12 | 2 | 0 | 11 | 2 | 1 | 47 | 13 | 24 | 84 |
| APP_CH | 9 | 1 | 4 | 2 | 1 | 11 | 5 | 0 | 9 | 1 | 0 | 13 | 10 | 1 | 3 | 2 | 0 | 12 | 29 | 3 | 52 | 84 |
| APP_DE | 8 | 4 | 2 | 1 | 3 | 10 | 1 | 13 | 0 | 3 | 0 | 11 | 5 | 0 | 9 | 3 | 3 | 8 | 21 | 23 | 40 | 84 |
| APP_DK | 11 | 0 | 3 | 10 | 1 | 3 | 9 | 4 | 1 | 3 | 0 | 11 | 8 | 0 | 6 | 8 | 1 | 5 | 49 | 6 | 29 | 84 |
| APP_ES | 12 | 2 | 0 | 9 | 0 | 5 | 10 | 4 | 0 | 7 | 0 | 7 | 12 | 1 | 0 | 12 | 2 | 0 | 62 | 9 | 12 | 83 |
| APP_FI | 10 | 0 | 4 | 9 | 3 | 2 | 8 | 2 | 4 | 2 | 0 | 12 | 12 | 0 | 1 | 5 | 1 | 8 | 46 | 6 | 31 | 83 |
| APP_GB | 9 | 0 | 5 | 4 | 10 | 0 | 6 | 0 | 8 | 3 | 0 | 11 | 13 | 1 | 0 | 8 | 4 | 2 | 43 | 15 | 26 | 84 |
| APP_IL | 6 | 0 | 8 | 13 | 1 | 0 | 11 | 0 | 3 | 8 | 0 | 6 | 12 | 0 | 1 | 12 | 0 | 2 | 62 | 1 | 20 | 83 |
| APP_IT | 11 | 3 | 0 | 5 | 4 | 5 | 5 | 8 | 1 | 0 | 0 | 14 | 8 | 4 | 2 | 7 | 6 | 1 | 36 | 25 | 23 | 84 |
| APP_JP | 4 | 2 | 8 | 0 | 14 | 0 | 0 | 0 | 14 | 1 | 0 | 13 | 1 | 13 | 0 | 5 | 7 | 2 | 11 | 36 | 37 | 84 |
| APP_KR | 12 | 1 | 1 | 0 | 14 | 0 | 2 | 0 | 12 | 5 | 0 | 9 | 13 | 0 | 0 | 6 | 8 | 0 | 38 | 23 | 22 | 83 |
| APP_NL | 10 | 1 | 3 | 5 | 4 | 5 | 4 | 4 | 6 | 0 | 0 | 14 | 6 | 3 | 5 | 2 | 2 | 10 | 27 | 14 | 43 | 84 |
| APP_SE | 10 | 0 | 4 | 7 | 4 | 3 | 0 | 0 | 14 | 1 | 0 | 13 | 10 | 0 | 3 | 0 | 0 | 14 | 28 | 4 | 51 | 83 |
| APP_US | 0 | 0 | 14 | 0 | 14 | 0 | 0 | 0 | 14 | 0 | 0 | 14 | 4 | 10 | 0 | 6 | 2 | 6 | 10 | 26 | 48 | 84 |
| APP_OT | 13 | 0 | 1 | 7 | 4 | 3 | 6 | 3 | 5 | 5 | 1 | 8 | 8 | 6 | 0 | 4 | 5 | 5 | 43 | 19 | 22 | 84 |
| FY_1991 | 11 | 0 | 3 | 3 | 11 | 0 | 14 | 0 | 0 | 11 | 1 | 2 | 13 | 0 | 1 | 6 | 8 | 0 | 58 | 20 | 6 | 84 |
| FY_1992 | 5 | 0 | 9 | 7 | 7 | 0 | 11 | 2 | 1 | 9 | 0 | 5 | 12 | 1 | 1 | 2 | 12 | 0 | 46 | 22 | 16 | 84 |
| FY_1993 | 1 | 0 | 13 | 2 | 11 | 1 | 8 | 6 | 0 | 11 | 1 | 2 | 10 | 4 | 0 | 1 | 13 | 0 | 33 | 35 | 16 | 84 |
| FY_1994 | 0 | 0 | 14 | 3 | 10 | 1 | 7 | 7 | 0 | 8 | 3 | 3 | 6 | 7 | 1 | 1 | 13 | 0 | 25 | 40 | 19 | 84 |
| FY_1995 | 0 | 0 | 14 | 1 | 13 | 0 | 10 | 3 | 1 | 10 | 3 | 1 | 6 | 8 | 0 | 0 | 14 | 0 | 27 | 41 | 16 | 84 |
| _cons | 0 | 14 | 0 | 0 | 0 | 14 | 4 | 8 | 2 | 3 | 11 | 0 | 0 | 14 | 0 | 0 | 0 | 14 | 7 | 47 | 30 | 84 |

Source: Own calculations based on EPO data – Patents filed 1990-1995

Table A4 - Country dependencies in the main model (18 country-specific regressions per value indicator)

| Variable | 5yrs Citations | | | EPC Family | | | Triadic | | | Survived 10yrs | | | Opposed | | | Composite | | | Total | | | TOT |
|----------|----------------|----|----|------------|----|----|---------|----|----|----------------|----|----|---------|----|----|-----------|----|----|-------|----|----|-----|
| | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | / | - | + | |
| CLMDEV | 2 | 0 | 16 | 7 | 1 | 9 | 3 | 0 | 15 | 9 | 0 | 9 | 13 | 1 | 4 | 3 | 0 | 15 | 37 | 2 | 68 | 107 |
| CLMLS | 14 | 4 | 0 | 10 | 7 | 0 | 11 | 7 | 0 | 16 | 2 | 0 | 14 | 1 | 3 | 12 | 6 | 0 | 77 | 27 | 3 | 107 |
| PRIO | 8 | 0 | 10 | 8 | 0 | 9 | 2 | 0 | 16 | 13 | 1 | 4 | 13 | 0 | 5 | 6 | 0 | 12 | 50 | 1 | 56 | 107 |
| EQUIV | 16 | 1 | 1 | 11 | 2 | 4 | 4 | 0 | 14 | 13 | 0 | 5 | 8 | 1 | 7 | 10 | 1 | 7 | 62 | 5 | 38 | 105 |
| HASDIV | 7 | 0 | 11 | 4 | 0 | 13 | 8 | 0 | 10 | 5 | 0 | 13 | 5 | 0 | 12 | 3 | 0 | 15 | 32 | 0 | 74 | 106 |
| ISDIV | 15 | 3 | 0 | 14 | 0 | 3 | 5 | 0 | 13 | 7 | 0 | 11 | 15 | 0 | 1 | 8 | 2 | 8 | 64 | 5 | 36 | 105 |
| PCT | 11 | 1 | 6 | 5 | 0 | 12 | 1 | 1 | 16 | 10 | 2 | 6 | 16 | 1 | 1 | 4 | 0 | 14 | 47 | 5 | 55 | 107 |
| ACCSRC | 16 | 0 | 2 | 14 | 0 | 3 | 16 | 0 | 2 | 16 | 0 | 2 | 12 | 0 | 4 | 13 | 0 | 5 | 87 | 0 | 18 | 105 |
| CUMUL | 15 | 1 | 2 | 5 | 11 | 1 | 5 | 0 | 13 | 11 | 3 | 4 | 7 | 11 | 0 | 12 | 6 | 0 | 55 | 32 | 20 | 107 |
| OCCAS | 13 | 4 | 1 | 11 | 2 | 4 | 4 | 14 | 0 | 7 | 11 | 0 | 14 | 0 | 4 | 6 | 12 | 0 | 55 | 43 | 9 | 107 |
| INVENT | 6 | 0 | 12 | 8 | 0 | 9 | 7 | 0 | 11 | 9 | 0 | 9 | 13 | 1 | 4 | 3 | 0 | 15 | 46 | 1 | 60 | 107 |
| IPC8 | 3 | 0 | 15 | 8 | 0 | 9 | 9 | 0 | 9 | 12 | 1 | 5 | 16 | 2 | 0 | 4 | 0 | 14 | 52 | 3 | 52 | 107 |
| BPC | 5 | 0 | 13 | 13 | 2 | 2 | 11 | 7 | 0 | 15 | 0 | 3 | 4 | 0 | 14 | 9 | 0 | 9 | 57 | 9 | 41 | 107 |
| NPC | 12 | 1 | 5 | 10 | 1 | 6 | 10 | 1 | 7 | 7 | 0 | 11 | 7 | 0 | 11 | 9 | 0 | 9 | 55 | 3 | 49 | 107 |
| CBOWN | 12 | 0 | 6 | 7 | 3 | 7 | 12 | 4 | 2 | 7 | 5 | 6 | 15 | 1 | 2 | 9 | 2 | 7 | 62 | 15 | 30 | 107 |
| ACAD | 15 | 1 | 2 | 13 | 2 | 2 | 12 | 6 | 0 | 13 | 2 | 2 | 11 | 3 | 0 | 15 | 1 | 2 | 79 | 15 | 8 | 102 |
| JC_02 | 8 | 0 | 10 | 0 | 0 | 17 | 8 | 1 | 9 | 3 | 0 | 15 | 13 | 2 | 3 | 1 | 0 | 17 | 33 | 3 | 71 | 107 |
| JC_03 | 7 | 0 | 11 | 7 | 2 | 8 | 8 | 1 | 9 | 10 | 1 | 7 | 8 | 0 | 10 | 8 | 0 | 10 | 48 | 4 | 55 | 107 |
| JC_04 | 2 | 0 | 16 | 4 | 0 | 13 | 9 | 1 | 8 | 2 | 0 | 16 | 13 | 3 | 2 | 3 | 0 | 15 | 33 | 4 | 70 | 107 |
| JC_05 | 6 | 0 | 12 | 9 | 4 | 4 | 13 | 3 | 2 | 7 | 0 | 11 | 11 | 6 | 0 | 8 | 0 | 10 | 54 | 13 | 39 | 106 |
| JC_06 | 10 | 0 | 8 | 9 | 8 | 0 | 10 | 1 | 7 | 10 | 0 | 8 | 7 | 6 | 2 | 13 | 4 | 1 | 59 | 19 | 26 | 104 |
| JC_07 | 12 | 3 | 3 | 7 | 10 | 0 | 12 | 1 | 5 | 10 | 0 | 8 | 14 | 3 | 0 | 11 | 5 | 2 | 66 | 22 | 18 | 106 |
| JC_08 | 12 | 6 | 0 | 7 | 10 | 0 | 9 | 7 | 2 | 10 | 6 | 2 | 12 | 6 | 0 | 8 | 10 | 0 | 58 | 45 | 4 | 107 |
| JC_09 | 12 | 1 | 5 | 11 | 6 | 0 | 14 | 3 | 1 | 9 | 1 | 8 | 15 | 3 | 0 | 14 | 3 | 1 | 75 | 17 | 15 | 107 |
| JC_10 | 11 | 7 | 0 | 3 | 14 | 0 | 11 | 1 | 6 | 13 | 3 | 2 | 8 | 9 | 0 | 5 | 13 | 0 | 51 | 47 | 8 | 106 |
| JC_11 | 7 | 11 | 0 | 8 | 6 | 3 | 10 | 7 | 1 | 11 | 7 | 0 | 13 | 0 | 5 | 6 | 10 | 2 | 55 | 41 | 11 | 107 |
| JC_12 | 6 | 12 | 0 | 6 | 11 | 0 | 5 | 12 | 1 | 13 | 5 | 0 | 12 | 5 | 0 | 2 | 16 | 0 | 44 | 61 | 1 | 106 |
| JC_13 | 5 | 13 | 0 | 7 | 10 | 0 | 6 | 12 | 0 | 8 | 10 | 0 | 15 | 3 | 0 | 5 | 13 | 0 | 46 | 61 | 0 | 107 |
| JC_14 | 12 | 1 | 5 | 10 | 6 | 1 | 11 | 7 | 0 | 9 | 7 | 2 | 14 | 2 | 2 | 7 | 7 | 4 | 63 | 30 | 14 | 107 |
| FY_1991 | 17 | 0 | 1 | 10 | 7 | 0 | 13 | 3 | 2 | 14 | 2 | 2 | 15 | 2 | 1 | 14 | 4 | 0 | 83 | 18 | 6 | 107 |
| FY_1992 | 11 | 1 | 6 | 13 | 4 | 0 | 11 | 4 | 3 | 14 | 0 | 4 | 16 | 2 | 0 | 12 | 6 | 0 | 77 | 17 | 13 | 107 |
| FY_1993 | 11 | 0 | 7 | 10 | 4 | 3 | 12 | 5 | 1 | 12 | 2 | 4 | 15 | 3 | 0 | 9 | 9 | 0 | 69 | 23 | 15 | 107 |
| FY_1994 | 8 | 1 | 9 | 12 | 5 | 0 | 11 | 5 | 2 | 14 | 2 | 2 | 12 | 5 | 1 | 8 | 10 | 0 | 65 | 28 | 14 | 107 |
| FY_1995 | 11 | 1 | 6 | 9 | 8 | 0 | 10 | 5 | 3 | 14 | 2 | 2 | 11 | 7 | 0 | 5 | 13 | 0 | 60 | 36 | 11 | 107 |
| _cons | 0 | 18 | 0 | 0 | 0 | 17 | 7 | 9 | 2 | 10 | 8 | 0 | 0 | 18 | 0 | 0 | 0 | 18 | 17 | 53 | 37 | 107 |

Source: Own calculations based on EPO data – Patents filed 1990-1995