Pre-emptive Patenting: Securing Market Exclusion and Freedom of Operation*

Dominique Guellec¹, Catalina Martinez² and Pluvia Zuniga*

¹ *Directorate for Science, Technology and Industry, OECD*
2, Rue André Pascal, 75775 Paris CEDEX 16
Tel: (33) 1 45 24 94 39. Fax: (33) 1 44 30 62 58

² *Institute of Public Goods and Policies, IPP-CCHS, Consejo Superior de Investigaciones Científicas, CSIC*

Albasanz, 26-28, E-28037 Madrid, Tel: (34) 91 602 25 43

**United Nations University and Maastricht Economic and Social Research Institute on Innovation and Technology*

1300 New York Avenue, Washington, D. C.

Tel: (1) 202 341 0059. Fax: (1) 202 312 4041

*This is a pre-copy-editing, author-produced PDF of an article accepted for publication in **Economics of Innovation and New Technology** following peer review. The definitive publisher-authenticated version [Pre-emptive patenting: securing market exclusion and freedom of operation, Economics of Innovation and New Technology, vol. 21, issue 1, pp. 1-29] is available online at:
DOI:<http://dx.doi.org/10.1080/10438599.2010.536378>*

Abstract

We investigate statistically the characteristics, functioning and incidence of pre-emptive patenting, defined as patent filings whose main effect is to hamper the grant of other patents. Patent applications can be used defensively to prevent the grant of exclusive rights over markets and technologies, in order to ensure freedom of operation or keep competitors out of a given technological field. Combining data from examination outcomes and prior art at the European Patent Office (EPO), we develop a methodology to identify pre-emptive patent applications. We find evidence of pre-emption associated to patent applications cited as compromising patentability while not being deemed relevant to the state of the art. We also find that, amongst them, those which are withdrawn have the strongest pre-emptive power. The coincidence of low inventiveness and high pre-emptive impact supports the idea that some of these patents may be strategically designed by their applicants to block patenting by others.

Keywords: Patents; citations; pre-emptive patenting; blocking patents; offensive and defensive patenting.

JEL-classification: C25, C51, K41, L00, L20

* We thank seminar audiences at the Université de Paris 1-CES, Université de Paris 2-ERMES, University College Dublin, Universitat Autònoma de Barcelona and participants at the EPIP 2007 conference (Lund, 20-21 September 2007), the 3rd ZEW conference on the economics of innovation and patenting (Mannheim, June 13-14 2008), and the Conference Knowledge for Growth: European Strategies in the Global Economy (Toulouse, 7-9 July 2008) for their comments. The views expressed in the paper are those of the authors and do not necessarily reflect those of the OECD (Organisation for Economic Cooperation and Development) nor of the CSIC (Consejo Superior de Investigaciones Científicas). We thank Stéphane Maraut for his aid in the creation of the specific database of patent indicators needed for this research.

* Corresponding author.

E-mail addresses: dominique.guellec@oecd.org, catalina.martinez@cchs.csic.es, pluviaz@hotmail.com

1. Introduction

The traditional role of patents is to provide patentees with an exclusionary power over the use of a particular invention. However, as evidenced in different business surveys, certain patents instead, are filed by firms in order to prevent others from obtaining this power (Cohen et al. 2002; Duguet and Kabla 1999; Blind et al. 2006). The use of patents as a means of preventing other parties from obtaining a patent on a related invention points to the central role of patents in the technology and market strategy of firms.

The increasing patenting activity worldwide (which has more than doubled in the US and in Europe since the mid-1990s) suggests that businesses are devoting more resources to protecting their intellectual property with patents or to defending themselves against the patents of others. In this setting, pre-emptive patenting strategies – aimed at hampering patenting by others – would be both an outcome and a factor of the increasing number of patent applications: they are partly a reaction to the growing number of applications which might hamper businesses' freedom to operate, while contributing themselves to the patents "arms race" by triggering in turn reactions of competitors. The effect of this kind of patents on the overall quality of the patent system is however not clear. On the one hand, they can help maintain the quality of granted patents, hampering the patentability of low quality applications; on the other hand they may be of relatively low quality themselves.

In this paper we aim to identify patent applications used defensively to pre-empt others from getting their patents granted. We evaluate the idea that generating prior art through the patent system may be a means of getting freedom to operate and may also act as a barrier to entry into a given technology field for potential or actual rivals. This type of behaviour is addressed in the theoretical literature on pre-emptive patenting, where incumbent firms patent substitutes of their products to prevent the entry of rivals (Gilbert and Newbery 1982;

Reinganum 1983; Vickers 1985). We argue that there is a strategic motivation to disclose inventions for the simple reason that it generates prior art: it makes knowledge advances public and not patentable, limiting the possibilities for rivals to patent inventions related to the disclosed information. Theory explains that the publication of an invention can provide an advantage to the inventor. Disclosure extends the patent race (Baker and Mezzetti 2005; Bar 2006) which raises the costs of competing (making some firms drop out the race) but allows firms to gain time until a breakthrough discovery is made. We hypothesise that disclosure through the publication of a patent application can be enough to pre-empt others from holding patents in the field of interest of the applicant. Applicants may file patents at the periphery of an important invention (patented or not) with the single purpose of limiting patenting of related inventions by others. They would file patent applications defensively to make sure they are generating visible prior art which is likely to compromise the novelty of other applications. They may also abandon the patenting process once the goal of preventing patenting by others is achieved, leading to the creation of a patent free area at the lowest cost. Withdrawn pre-emptive applications would endow their owner with no exclusive rights per se (as no patent is granted) but would also deprive competitors of a legal means of limiting freedom of operation on the market.

Most studies on defensive patenting have focused on the use of enforceable patents (patents that are granted) in strategies such as patent fences and patent pools, which also aim to ensure freedom of operation and provide protection against litigation (Hall and Ziedonis 2001; Schneider 2008; Harhoff et al. 2008). The empirical analysis of pre-emptive patenting and the role of patent publication as a defensive instrument have been given less attention. This paper intends to fill this gap. We provide new empirical evidence on the functioning and characteristics of pre-emptive patents, and on the importance of patent publication for pre-emption. There are several motivations underlying this investigation. First of all, there is ample anecdotal and survey

evidence pointing to the existence of strategic blocking but, to date, few statistical analyses at the patent level have been done to explore these issues.¹ The empirical examination of pre-emptive patenting is important to the extent that these strategies are fundamentally conceived to secure market exclusion, which is the first reason to patent, and because they may allow innovators to appropriate economic rents from previously patented core inventions. Second, research on the role of withdrawal as a defensive mechanism is hardly existent. A common assumption in survey studies is that strategic purposes are associated to patents that are granted, that is, applicants always finalise the patenting process. This paper will show that patent publication can be enough to hamper the grant of other patents. By generating prior art, the disclosure of an invention can destroy the novelty of subsequent patent applications on the same subject matter. Lastly, this paper also provides statistical evidence of the importance of the patent applications with the strongest pre-emptive power in total patenting activity (i.e. over time and across technologies), their functioning and characteristics.

Combining data from prior art and examination outcomes, we develop a methodology to identify patent filings consistent with pre-emption motivations. Patent data can be helpful in shedding light on the strategic behaviour of applicants and the use of the patent system, and is therefore complementary to anecdotal evidence and survey-based studies. We analyse search and examination outcomes of patent applications filed to the European Patent Office (EPO) between 1990 and 2000 and relate them to the different categories assigned to them by examiners in search reports to determine the patentability of other patent applications. We investigate the existence of pre-emptive practices in patenting by looking at the influence of patent references

¹ The term blocking is generally used in the literature to refer to defensive patent strategies. Blocking further patenting is what we call here pre-emptive patenting. We will preferably use the terms defensive and pre-emptive patenting in this paper, although we will sometimes refer to blocking patenting strategies where mentioning results from other authors who use that term.

on the fate of other (citing) patents and relate this impact to the technical contribution of cited patent references and their administrative status (i.e. pending, withdrawn, granted, refused).

The paper is organised as follows. After providing some background information and a description of our methodology, we present our empirical model aiming to identify pre-emptive power in cited patent references. A multinomial model is conducted to identify relations between different classes of patent references cited in search reports and the likelihood of refusal and withdrawal of their corresponding citing patents. Once the types of patent references with the strongest pre-emptive power are identified, we proceed to characterise them by comparing attributes with other types of filings with the aid of probit models. Based on the literature on the value of patents, we compare characteristics of inventions such as scope, research costs (number of inventors), cumulativeness of invention and scientific content. Sector-specific analyses are also conducted for chemicals-materials and pharmaceuticals-biotechnology. Lessons and policy implications are discussed at the end.

2. Economics of Pre-emptive Patenting

We understand pre-emptive patenting as a type of defensive patenting; referring to *patents (applications or grants) whose main motivation is to prevent others from patenting the same subject matter.*

This definition recognises the fact that to exclude others from patenting and ensure freedom to operate there is no need to obtain enforceable patent rights and a patent application can be sufficient, which leads us to explore the role of withdrawal as a pre-emptive mechanism. We are interested in assessing the role of pre-emptive patent publication defined as patent applications filed only to generate prior art and destroy the novelty of other applications. We exploit the fact that a patent application, by generating prior art, can actually be sufficient to pre-empt patenting by others when it destroys the novelty of subsequent applications on the same

subject matter, with no need to be enforceable, something that is generally neglected in the economic literature.

While there is no agreed definition of strategic patenting (in contrast to patenting for traditional motives such as to ensure market exclusion and protect against imitation, licensing and other commercialisation means), most experts recognise two main orientations: defensive and offensive (e.g. Arundel and Patel 2003; Shapiro 2006).

Defensive patents are primarily motivated by a desire to secure freedom to operate while at the same time, possibly serving to prevent entry by others into given markets or technologies (De Rassenfosse and Guellec 2009). In complex technologies, where the production of a new product involves inter-dependent technologies and rights owned by different applicants like in semiconductors and other electronic technologies (e.g. Hall and Ziedonis 2001), firms tend to patent intensively in order to create thickets of complementary technologies and use patent grants as bargaining chips in cross-licensing negotiations. In discrete technologies, e.g. pharmaceuticals and chemicals, – where inventions tend to be substitutes rather than complementary and where a single patent can be related to a line of products – firms would tend to build fences of substitute patents (Schneider 2008). Conversely, offensive patents aim at preventing others from using a technology. They can serve to leverage opportunistic licensing deals or advantageous settlement conditions from litigation threats (Shapiro 2006). They would be used mostly against firms that already own patents and make commercial use of them. Contrarily to offensive patenting, we argue that defensive patenting aiming at blocking entry to others to patent does not necessarily require the patent to be granted to serve its objective: publication of inventions could be enough to destroy novelty and hamper patentability of other inventions.

2.1. Theoretical Literature

The concept of pre-emptive patenting was first investigated in the theoretical economics literature, where it is broadly described as incumbents patenting a substitute technology before rivals, in order to deter entry (into patenting and so into markets).

According to Gilbert and Newbery (1982), an incumbent firm, motivated by the ex-ante market power and in reaction to a threat of entry, will find it valuable to patent a substitute invention to pre-empt entry. When entry into an industry can only take place through the invention and patenting of a substitute for a monopolist's product, they show that it is rational for the incumbent, under certain conditions, to pre-empt entry of potential competitors by patenting the substitute himself and letting the patent sleep (by neither producing the protected invention nor licensing the patent) when it is not profitable for him to produce both his original product and the substitute. Patenting a substitute technology would always be profitable to the incumbent because it enables to preserve monopoly profits, which typically exceed the duopoly profits that the incumbent would obtain with entry. For the pre-emption threat to be credible, the incumbent needs to commit the R&D needed to develop the innovation even if it is profitable not to employ the innovation once produced. Another basic result from the model of Gilbert and Newbery is that the more drastic the underlying innovation on which the R&D competition is based, the lower the incentives for and the profits with pre-emptive patenting. Thus, for small innovations, the incumbent loses more than the entrant gains if the entrant obtains the patent.

Reinganum (1983) shows that the results of Gilbert and Newbery always hold when the innovation process is deterministic, but when uncertainty is introduced the entrant may sometimes have more incentives to patent than the incumbent. She argues that more drastic innovations may also be subject to greater uncertainty, concluding that the predictions of Gilbert and Newbery will be more appropriate for incremental innovations than for drastic ones.

In turn, Vickers (1985) considers several incumbent oligopolists, rather than a monopolist like in Gilbert and Newbery, and shows that for minor innovations, incumbents have more chances to succeed in preventing entry of potential entrants by patenting the underlying technology when they pool their incentives in a joint R&D venture than when they behave non-cooperatively.

Traditionally, patenting in theoretical models is restricted to grants (winning the patent race). In other words, it is assumed that, in order to block entry into patenting by others, applicants must go through the whole patenting process. The economic literature has barely considered the role of patent applications (not necessarily granted) as mechanisms for defensive disclosures, even though patents have distinctive features that may make them more attractive than other defensive publishing means, notably visibility to patent examiners and clear date of invention (Annex 2).

Recent theoretical studies have analysed the role of defensive publishing in patent races, showing that disclosure can help gain time by raising the patentability threshold and thus delaying patent filings until further research is done. According to Baker and Mezzetti (2005), a longer race might offer a firm trailing behind an opportunity to catch up, while for a leading firm, extending the race raises the costs of competing, which will in certain circumstances discourage the laggard from racing so aggressively (Baker and Mezzetti 2005). In particular, a firm that holds a patent over a core technology may find it worthwhile to publish in order to enjoy the stream of payoffs from her *actual* patent for a longer period of time. Bar (2006) shows that when firms bear different costs of investment, the low cost firm may gain from publishing if by prolonging the race it drives the high cost firm out of the race.² She also demonstrates that a

² According to Bar (2006), a lagging firm may have stronger incentives to disclose in order to prevent the leader to have the patent the far she is in a race and the closer the rival is to winning.

lagging firm may have stronger incentives to disclose to prevent the leader from getting the patent the farther she is in a race and the closer the rival is to winning.

2.2. Empirical Literature

Empirical studies investigating the strategic uses of patents are often based on qualitative information (company declaration of uses) coming from business surveys, where strategic motives, such as blocking competitors and preventing suits, are usually amongst the top motivations to patent, right after the traditional motive of protecting inventions from imitations. Alternatively, some researchers rely on information contained in patent documents, such as filing procedures and citations, to investigate strategic behaviour in patenting.

2.2.1 Evidence from Surveys

In France, Duguet and Kabla (1998) find that securing own technological room to manoeuvre is the decisive driving force behind strategic patenting. Defensive blocking and improving negotiation positions were mentioned by 62% of all enterprises as reasons for patenting. In Germany, Blind et al. (2006) find that defensive blockade of competitors (i.e. securing own technological flexibility) is deemed important for 72% of companies, while offensive blockade of competitors (i.e. hindering competitors from technological developments) is deemed important by 69%. And, in the United States and Japan, the Carnegie Mellon Survey finds that the prevention of rivals from patenting related inventions (called patent blocking) is the most pervasive motive for patenting after the prevention of imitation for 82% of United States and 93% of Japanese respondents (Cohen et al. 2002).

Using information from the US Carnegie Mellon survey, Ceccagnoli (2009) shows that pre-emption - declared by companies as motivation to patent - tends to improve remarkably the appropriability of returns to R&D (especially for incumbents with strong market power and

facing high threats of entry), as evidenced by the positive impact on the stock market valuation of a firm's R&D assets. Hence investors price the reinforced value of assets when market power is protected with entry foreclosure, consistently with the theoretical predictions.

Henkel and Pangerl (2008) show that defensive publishing, understood as an “*insurance against being excluded from use of the respective technology*”, is widely practiced by German firms through a variety of methods including the patent system (firms use specialised internet providers, peer-reviewed journals or public notice boards, etc.). Eleven companies out of 37 (30% of their sample), most of them large ones, claimed to practice defensive publications systematically by filing patent applications (*i.e.* applying for a national patent and then letting the application lapse, so that it is deemed withdrawn by the patent office). One of the largest German firms interviewed recognised that it published defensively about 30% of its inventions using the patent system this way.

Evidence on the role of patent application withdrawal as a defensive mechanism is also found in the EPO Applicant Panel Survey 2007 report (EPO 2008), which contains a small section on the reasons for withdrawals. Telecommunications, followed by civil engineering and thermodynamics, appear as the fields where the defensive component is more widespread (during 2006, 99% of the applicants in telecommunications with withdrawn filings and 32% in civil engineering and thermodynamics, declared that 21-50% of their withdrawals were done defensively).³ In contrast, biotechnology and chemicals are the fields where defensive

³ In the European Applicant Panel Survey 2007 (EPO 2008) the reasons for withdrawal inquired are: not complying with formal requirements, not achieving patentability criteria, e.g. novelty, non-obviousness and industrial applicability (*i.e.* discouraging search report written by EPO, negative communications sent out by EPO during substantive examination), reduction of the scope of the invention required by the EPO (which translates into less economic expectations), disclosure of new prior art during the substantive examination of the file, defence through disclosure, fading perceived economic importance of the invention and other reasons. The most frequent reasons for withdrawal are: not complying with formal requirements, discouraging search report written by the EPO, and negative communications sent out by the EPO during substantive examination. Percentages of withdrawn filings by motivation are not provided. The results of the survey, which was addressed to a representative sample of applicants having filed patents at EPO in 2006, can be found at www.epo.org. The results mentioned here can be found in Tables 95 and 96, pp.106-107.

withdrawals are done more frequently, but the practice is concentrated in fewer firms (8% of applicants in biotechnology, pure and applied organic chemistry and polymers with defensive withdrawals during 2006 report that as much as 51-80% of their withdrawals were done defensively).

2.2.2. Evidence from Patent Documents

An increasing number of empirical studies on strategic patenting rely on patent information. Graham and Mowery (2004) find evidence on the strategic use of patent application procedures by applicants in the United States through the system of continuations applications. Other studies suggest that the motivations behind challenging the validity of patents in opposition procedures at EPO or re-examination procedures at USPTO are not only related to value but also to strategy (see Harhoff and Hall 2003; for the case of cosmetics). Harhoff and Reitzig (2004) use categories of patent references in their model explaining the likelihood of EPO opposition in the pharmaceutical and biotechnology fields, finding that if the validity of patents granted had been questioned by the examiner (by including conflicting references in their search report), third parties have more ground to challenge them through the opposition system. They conclude that the likelihood of opposition increases with patent value and is particularly frequent in areas with strong patenting activity and with high technical or market uncertainty. Van Zeebroeck and van Pottelsberghe de la Potterie (2008) provide evidence on the positive association of filing routes (filing PCT route) and drafting styles (excess claims filed, the drafting by assembly, the parent of divisional applications), to patent value indicators. They also find that these determinants are the most stable of all (compared to number of inventors, backward patent citations, portfolio patent size).

Citation categories in EPO search reports compromising patentability of new inventions (X, Y and E citations) have also been used to infer blocking strategies by applicants. Harhoff et

al. (2008, 15) propose measures of mutually blocking patent strategies between companies based on the identity of the applicants of “critical references”, that is, “classified as limiting the patentability of the invention to be patented”. Grimpe and Hussinger (2008) evaluate the “blocking potential” of patent portfolios based on the number of conflicting forward citations they received and find that the deal value of a target in merger and acquisitions in Europe increases with the blocking potential of its patent portfolio.

3. Methodology and Data Sources

According to our definition, pre-emptive patents would be patent applications cited as compromising novelty in other patent applications and which have *intentionally* contributed to their refusal or withdrawal. But how can we distinguish (ex-post) patents filed with the intention to hamper the grant of other patents from the rest? What we can do at best is to identify patterns consistent with the expected behaviour presented in our hypotheses. We would expect withdrawn or refused applications to have more patent references indicating conflicting prior art than granted patents, but the question is whether those references are conflicting because they represent a relevant contribution to the art and thus “naturally” block the patentability of further filings, or because they were strategically designed to limit patentability in a specific field. Following the literature, pre-emptive patents would be expected to cover more incremental inventions or substitutes of existing inventions than the rest of applications; in other words, their original contributions to the art are likely to be rather limited or null.

Since our objective is to identify patent applications that have been filed with the sole purpose of preventing others to patent the same subject matter, ideally, we want an indicator that captures the ex-ante intentions of applications based on information on their actions ex-post, knowing that it would necessarily be a proxy, as it will be fully based on bibliographic information contained in patents (without relying on declarations of intentions by applicants

conveyed in surveys). This section presents the methodology and data used to build our indicator and some caveats to be taken into account when interpreting results.

3.1. Methodology

Our best approximation to operationalise our definition of pre-emptive patents (patents filed to prevent patenting by others) using bibliographical information from patent documents is as follows, as displayed in Figure 1: *A pre-emptive patent is a patent cited as a conflicting document (compromising novelty of other inventions) in the search report of other patent applications which has never been cited as a document relevant to the state of the art, and is associated to the refusal or withdrawal of the citing patent.*

Figure 1 about here

The search reports for direct EPO applications, and for international applications filed at EPO to follow the PCT route, are a very rich source of information about potentially conflicting interactions between patents. They provide information on the state of the art relevant for the patentability of the patent application. Patent examiners classify relevant prior art in order to characterise the novelty and inventive step of the claimed invention. Citation categories X, Y and E designate prior patent art that compromises the novelty and patentability of new applications, whereas citation category A corresponds to patent references that are relevant to the state of the art (see Annex 1 for more information). The fact that guidelines explicitly require examiners to be objective and selective in the documents referenced in their prior art search, makes search reports even more suitable to monitor state of the art that affects the patentability of new inventions, distinguishing between conflicting and relevant prior art (Michel and Bettels 2001; Webb et al. 2005).

We make a distinction between the following four categories of patent applications based on their full history of forward citations: the non cited (do not appear as reference in any later filing at EPO); the ‘Pure-X’ patent references (cited only as conflicting, i.e. in the X, Y or E category), the ‘Pure-A’ patent references (cited only as state of the art, i.e. in the A category) and the ‘X&A’ patent references (cited both as conflicting and state of the art in subsequent filings).⁴ Our interest lies in category Pure-X, that is, applications cited for compromising (partially or completely) the patentability of other applications, which have never been cited as a reference to the general state of the art. It is therefore likely that their contribution to the state of the art is not commensurate to their ability to prevent patenting by others. Our methodology will be validated if patent applications of this kind (Pure-X) show a pre-emptive power, that is, if they are equally or more strongly associated to the refusal or withdrawal of the citing patents than other types of cited applications.

We also evaluate the legal status of the cited patent references, distinguishing between granted, withdrawn and refused patent references in each of the categories previously described. As argued earlier, defensive patents do not need to be granted, as the uncertainty created by their filing and disclosure may serve their objectives without it being necessary to assert them in court. However, we should acknowledge that pre-emption can also occur with granted patents – and this strategy has been perhaps the most widely described in the literature, in which case their holders could use them to keep competitors off the market by exerting their exclusive rights or to

⁴ A few examples may be helpful to better understand how these forward citation profiles are built. First, if a patent application is cited in the search reports of two subsequent filings as conflicting and as relevant to the state of the art, that is, first under the A category in the search report of a patent application, and some time later under the X category in the search report of another patent application, it will be categorised as type X&A. Second, if a patent application is always cited in the search reports of three subsequent filings as a conflicting document, first under category X in one application, then under category Y in another and finally under category X in another, it will be categorised as Pure-X. Third, if a patent application is always cited in the search reports of subsequent filings as relevant to the state of the art, under category A, it will be categorised as Pure-A.

defend themselves from offensive patenting strategies by others.⁵ Again, our methodology will be validated if we find that withdrawn pre-emptive applications (Pure-X patent withdrawn) are associated to the refusal or withdrawal of other patent applications, as that would mean that Pure-X patent applications can be used to hamper the patentability of other patents even if they fail to be granted, just by generating conflicting prior art with a low degree of inventiveness.

Three caveats need to be taken into account concerning our methodology. The first is about *false positives* that our indicator could capture, that is, patent applications that will be identified as pre-emptive but are not. The second, about *false negatives*, that is, patent applications that are pre-emptive but our indicator would fail to capture. The last caveat refers to our methodological strategy.

First, we are aware that our indicator will classify as pre-emptive patents some low quality applications that were filed with the traditional exclusion motives. For instance, as regards pre-emptive withdrawn applications, it is difficult to establish the line between induced and defensive withdrawals, making it hard to assess if the intention of applicants was initially to pursue the patent process or not. For patent applications filed with the intention of getting a grant, the decision to withdraw is the result of complex tradeoffs between patent scope (restrictions imposed by examiner) and patent value (market potential of the invention).⁶

A significant number of withdrawals may correspond to filings that do not embody sufficient novelty to be deemed patentable in the view of the applicant or the EPO, possibly after

⁵ Patentability requirements, grant rates and the costs to get a patent can largely differ across jurisdictions. In some national EPC member states, for instance, patents may be granted only on the basis of formal requirements, with no substantial examination (e.g. Spain). On the other hand, the costs of keeping the patent throughout the full examination procedure might be relatively small for some applicants compared to the benefit of taking the chance of it being granted, which may reduce the incentives to withdraw the application.

⁶ As explained by Graham and Harhoff (2006, 13), "For an economically important invention, a patent holder may be willing to accept even a highly restricted patent (low scope) while for an economically unimportant one, the patent holder may simply withdraw the application. Applicants with valuable patents can be expected to put more effort into securing a patent grant (even if the claims are narrowed by the examiner during the give-and-take of the examination process)."

a communication from the examiner informing about the high likelihood of refusal. Induced withdrawals or anticipated refusals occur for up to 23 percent of all applications at the EPO (Stevnsborg and van Pottelsberghe de la Potterie 2007). In fact, Lazaridis and van Pottelsbergue de la Potterie (2007) show that up to 54% of withdrawals at the EPO may be considered as induced by the work of examiners (i.e. withdrawals that occur just after the search report or after the communication that takes place during the substantial examination process) and can be thus interpreted as anticipated refusals. We will also use information on the timing of withdrawal in Section 5 below in order to characterise pre-emptive withdrawals and differentiate between and induced withdrawals and defensive ones.⁷

Second, we acknowledge that our indicator cannot identify all pre-emptive patents. Indeed, the “most powerful pre-emptive patents” are not necessarily observed (or easily observed) with the aid of patent data as they will simply deter further patent filings by other firms in the surroundings of the protected area. It is of course more difficult to interpret the absence of patent applications in a given area than to interpret the information provided by actual patent filings, and we only do the latter in this study. Further understanding is needed about the nature of these patents and how to identify them. Furthermore, we would also be ignoring applications that were intended to be pre-emptive but missed their objective. By this, we mean applications that are filed with the intention of preventing others to patent but were never cited as compromising the patentability of other inventions.⁸ We also acknowledge that a patent that is granted and validated with no intention to enforce it whatsoever, but that aims to ensure freedom

⁷ A withdrawal can occur at any stage of the patenting process at EPO: before publication, after publication, before or after examination, and before or after a grant.

⁸ It is hard to imagine that applicants would actually reveal their real intentions when applying for a patent (except in the case of very close competition between very large patentees, e.g. INTEL, who tend to announce defensive patenting in journals and magazines). Identifying pre-emptive intentions would require special information to be collected, and actually asking firms (i.e. business survey).

to operate (and hamper patenting by others), could also fall into the conceptual definition of a pre-emptive patent.

And third, we are aware that our methodology does not take into consideration pre-emption that did not prevent the grant of certain patents but actually harmed their scope. In other words, there will be patents that are granted and did have XYE references compromising patentability, but due to these conflicts, lost a substantial number of claims in the examination process.⁹ This important question will be examined in a future study once data on changes of patent claims becomes available.

3.2. Data Sources

We have drawn data for this study from several sources. The EPO Worldwide Patent Statistical Database (PATSTAT) April 2007 edition is the source for information on citations up to end 2006 (selecting only those made by examiners in EPO and EPO-PCT search reports), filing years, grants and country of origin of the first applicant for all EPO applications filed in 1990-2000 citing either other EPO patent applications or equivalents of EPO applications.¹⁰ Information on citations, IPC classes, number of inventors, grants, filing years and applicants for EPO applications and EPO equivalents of non-EPO cited in EPO patent applications filed in 1990-2000 also comes from PATSTAT April 2007.

All cited and citing EPO applications in the sample were distributed by technology area using the OST-INPI/FhG-ISI correspondence (2nd revision) between IPC classes and seven broad technology areas, based on information from EPOLINE on their main IPC class (defined as the first IPC listed in the patent document).

⁹ We have no data on the change in the number of claims during examination. The databases available to us only report the last status reported.

¹⁰ We thank Stéphane Maraut for having developed the algorithm to identify EPO equivalents for non-EPO applications cited in the search reports of EPO applications.

Additional information on legal status, not included in PATSTAT, comes from other sources. EPOLINE is the source for information on refusals and withdrawals (as of May 2007) for the citing and cited applications extracted from PATSTAT; and the EPO legal status database (INPADOC-PRS) is the source of withdrawal dates for cited patents. We excluded from the sample of citing EPO applications those not citing other EPO applications or their equivalents, as well as those still pending as at May 2007.¹¹

For the selection of cited EPO patent applications filed by business applicants we have relied on data provided by the OECD on EPO patent applications by type of applicant (institutional affiliation as defined in the Frascati Manual) based on the algorithm developed by van Looy et al. (2006) for Eurostat. Information on the size of patent portfolios of the business applicants of cited EPO applications was obtained from the OECD Harmonised Names of Applicants database (HAN).

Finally, information on the number of claims of cited EPO applications comes from the EPO EPASYS database.

4. Empirical Examination

We investigate the relative capacity of Pure-X cited applications to hamper the grant of other patents by looking at the procedural outcome of their citing applications. We also examine whether their pre-emptive power changes depending on their own procedural status: withdrawn, refused, granted or pending.

4.1. The Model

In order to identify patent applications with pre-emptive power, we relate the fate of a patent application to the characteristics of the patent references cited in its search report, controlling for

¹¹ The share of pending applications (as of May 2007) in the total number of citing applications included in the analysis is less than 1% for those filed between 1990 and 1994 and increases gradually thereafter, to 6% for applications filed in 1997, 11% in 1998, 18% in 1999 and 27% in 2000.

other aspects of the citing patent application, such as country of residence of applicants, technology field and filing year.¹²

The possible outcomes of a patent application to the EPO for filing years 1990-2000, are defined as a categorical dependent variable j :¹³

$$j = \begin{cases} 1 & \text{if the patent application is granted} \\ 2 & \text{if the patent application is withdrawn} \\ 3 & \text{if the patent application is refused} \end{cases}$$

If the error terms are independent and identically Gumbel distributed, with location parameter 0 and scale parameter x , the probability that a given patent application results in outcome j is given by:

$$\Pr(Y_i = j | x_i) = \frac{e^{x_i \beta_j}}{1 + \sum_{k=1}^2 e^{x_i \beta_k}}$$

The multinomial logit model can only be justified under the IIA (Independence of Irrelevant Alternatives) assumption (see Greene 2003); the errors in the random utility model are assumed to be independent across choices.¹⁴ In other words, the ratio of the probabilities of any

¹² We would like to control for the nature of the invention regarding its quality but given the nature of data and the definition of patent categories of analysis, the inclusion of variables such as forward citation would introduce redundancy in the models (for determinants of patent quality and value see Lanjouw and Schankerman 2001; Harhoff et al. 1999). We should also recall that given that some of the variables used in our model are frequently a result of the examination (e.g. granted patents have a minimum threshold of quality as they accomplish the requirement of novelty and inventive step), we are confronted with simultaneity between outcomes of examination and characteristics of patents. Further, neither a theoretical framework nor an empirical structural model linking all these variables exists to date; given the complexity of such process. We are focusing here on the information contained in the search reports (prior art); which is rather an exogenous factor (and we control for technology classes, filing years and country of residence of the applicant). Yet our dummy variables on the types of patent references will inevitably absorb effects related to other characteristics of the application such as novelty.

¹³ Although some withdrawals can be considered as anticipated refusals; as long as the decision to abandon the patenting process depends on the applicant, we decide to keep it as a separated outcome from refusals.

¹⁴ The IIA means first that the odds ratio above does not shift when alternative choices are added. Second, when there is nominal variable that is not really a choice, the IIA assumption says that there are no factors affecting the

two alternatives is independent from the choice set. Hausman and McFadden (1984) propose a way to test whether the IIA assumption holds. The Small-Hsiao test indicates that the assumption of Independence of Irrelevant Alternatives has not been violated (the null hypothesis of IIA cannot be rejected).¹⁵

Two groups of factors are considered and their influence tested on the fate of citing patent applications (grant, refusal and withdrawal, with grant as the reference outcome) in two multinomial logit models: i) forward citation profiles of patent references; and ii) forward citation profiles and procedural status of the patent references (granted, withdrawn, refused, pending). All the independent variables are dummies referring to the citing application having (or not) that type of backward citation in its search report.¹⁶ We control for technology fields (7 dummies designating technology areas as defined in the OST-INPI/FhG-ISI nomenclature, 2nd revision; the reference being class 7, construction-consumer goods), filing years of the citing patents 1990-2000 (reference being 1990) and country of residence of the first applicant of the citing patent (nine country dummies: United States, Japan, Germany, France, United Kingdom, Switzerland, Australia, Canada and any other country; reference Canada).

Guellec and van Pottelsberghe (2000) also analyse the influence of patent characteristics on the fate of EPO applications focusing on the determinants of grants and looking at factors such as country of inventor, technological field and designated states, but they do not analyse the influence of different types of backward citations on the probability of grant. In turn, Schneider (2007) looks at the relation between each of the three possible outcomes of EPO patent

probability that an observation falls into one category that: a) are left unexplained in your model of this outcome, and b) also influence the chances that an observation ends up in a different category.

¹⁵ The results of the Small-Hsiao test are: omitted outcome withdrawal: $\chi^2(29)=29.913$ with $P>\chi^2=0.418$; omitted outcome refusal: $\chi^2(29)=25.170$ with $P>\chi^2=0.669$.

¹⁶ We have evaluated the model using the number of references belonging to each of those citation groups. The results are similar to those obtained with dummy variables.

applications (grant, refusal and withdrawal) and the number of conflicting backward citations in their search reports, together with other factors.

4.2. Results

In our sample of 425,582 non pending citing EPO applications with filing years 1990-2000, 29% of the filings contain at least one X patent reference, 21% at least two Y patent references (since they need to be cited in combination with other patents, by definition), whereas 71% of applications report A patent references. According to our groupings based on the whole history of forward citations received by the patent references, 19% of applications cite patent references of the Pure-X group and 34% patent references of the X&A group under the X category. The most frequent type of patent references consists of X&A patent references cited as A, by 46% of the filings, followed by the Pure-A, cited by 38%. Summary statistics are given in Table A2 in Annex 2.

Table 1 provides the results for the different multinomial models. In a first model (**MNL Model 1 in Table 1: citation profile**) we break down patent references into different groups according to their forward citation history.¹⁷ Thus, depending on how they are cited elsewhere, we distinguish four groups: X/Y/E patent references of the Pure-X group, X/Y/E patent references of the X&A group, A patent references of the X&A group and A patent references of the Pure-A group. Absent strategic concerns, we would expect conflicting references which have been cited as relevant state of the art in the search reports of other patent applications to have a

¹⁷ We first investigated whether specific types of references are associated individually more strongly with citing outcomes. Not surprisingly, estimated marginal effects showed that conflicting references (X, Y and E) and state of the art citations (A) have a different incidence on the likelihood of a patent application being eventually granted. Having at least one patent reference in a conflicting category increases significantly the probability of withdrawal (more than 3% for Y and more than 6% for X and E), whereas it is reduced when the patent application has at least one A patent reference (by almost 4%), all else equal. These results are consistent with the findings of Schneider (2007), showing that withdrawals are more likely to occur when there exists conflicting prior art. Results of this regression are available upon request.

stronger pre-emptive power (e.g. provoking more withdrawals or refusals) than patents which are only cited as conflicting but do not appear to be relevant to the state of the art, because they are presumably of higher technical quality. However, the results of this model contradict such expectation, showing clearly that Pure-X patent references have a stronger pre-emptive power than their counterparts, and by far so. More precisely, the probability of withdrawal of a patent application increases by almost 8% when it cites at least one Pure-X patent reference (probability of refusal increases 0.08%), whereas citing as X a patent which has been elsewhere cited as A increases the probability of withdrawal by only 4%. The likelihood of withdrawal for applications with Pure-X references is twice as great as that of applications with patent references belonging to the X&A group. Patent references of the A category, either when they have been cited as X elsewhere or when they have been always cited as A (Pure-A), diminish the probability of withdrawal of their corresponding citing applications.

In a second model (**MNL Model 2 in Table 1: citation profile and procedural status**) we test the influence of the procedural status of the three different groups of patent references used in the first model. As mentioned earlier, without strategic filings we would expect granted patent references to be associated with a higher likelihood of refusals or withdrawals (with respect to grants) of other patent applications than withdrawn or refused patent references, or even pending ones, because of their higher technical quality. However, estimates indicate that by and large the patent references with the strongest pre-emptive power are those withdrawn and belonging to the Pure-X group of patent references. Paradoxically, the probability of withdrawal increases by almost 12% for applications having withdrawn patent references of the Pure-X group. Further, their impact is significantly different from the impact of pure-X granted patent

references; and significantly different from the Pure-X refused.¹⁸ Overall, Pure-X patent references have a positive influence on the probability of withdrawal of their corresponding citing patent applications, compared to their grant, regardless of their status.¹⁹ Withdrawal seems to confer a “pre-emptive” trait to other classes of patent references too, as also withdrawn patent references under the A category have a positive impact on the probability of withdrawal of the citing patents. This finding holds when we conduct the analysis for two periods (patents being filed during the period 1990-1995 and patents being filed during the period 1996-2000).²⁰ One possible explanation here is that withdrawn applications can be broader in scope than granted ones, as during the examination process the scope of patents is often reduced by the examiner (so that the granted patents corresponds more closely to the actual invention, usually overstated in the initial filing by the applicant).

****Table 1 about here****

5. Conflicting, not Relevant to the Art and Withdrawn

Let us now characterise those patent applications identified in the previous section as having the strongest pre-emptive power when compared with other applications: withdrawn applications which have only been cited as conflicting references, never as relevant to the art (Pure-X withdrawn). In what follows we analyse the characteristics of all Pure-X withdrawn, regardless of the fate of their citing patents, not only the successful ones that effectively led to

¹⁸ The χ^2 tests for equality of coefficients are significant at 1%: 450.59 for the former and 19.08, for the latter comparison.

¹⁹ The coefficient of pending Pure-X references is not significantly different from the coefficients of withdrawn Pure-X and refused Pure-X.

²⁰ The strong pre-emptive power of pending pure-X patent references disappears when we consider filing years 1990-1995 for the citing patents. The results of estimating Model 2 on cited status by sub-periods (1990-1995 and 1996-2000) with the objective to isolate the influence of truncation due to pending citing applications and pending patent references not only confirm the characterisation of Pure-X withdrawn as the category of patent references with the strongest pre-emptive power, but they also discard the influence of pending patent references (of any category) finding it non-significant for the 1990-1995 period. We also tested the influence of self-references, finding that the increase in the probability of withdrawal (with respect to grant) for applications citing Pure-X patent references is roughly the same for both self and non-self references.

pre-emption. Our justification for doing this is that we are interested in them insofar as they could help us infer the *intention* of the applicant at the time of filing (regardless of whether they block further patentability or not). We want to know in which dimensions (patent scope, invention costs, applicant portfolio size, etc) they differ from the rest of (cited) patents and the rest of withdrawals.

5.1. A Rising Trend

Pure-X withdrawn patent applications have increased over time roughly to the same degree as total EPO filings, with an increase of more than 30% between 1990 and 1998.²¹ This growth has been in contrast to a decrease in the number of total cited applications and total withdrawn applications among the cited. The share of Pure-X withdrawn with respect to all cited has gone from 7% in 1990 to 13% in 2000, whereas the share with respect to all withdrawn references has increased from 26% to 51% (Figure 2).

****Figure 2 about here****

The rise in citations of type XYE relative to A can be in part explained by a stronger inclination by examiners to focus on prior art that compromises novelty and less attention to search and cite prior art that is not prejudicial to the patentability of the invention under examination (influenced by programs implemented at the EPO aiming to accelerate examination and improve efficiency in procedures, notably the BEST Programme implemented in 2000).²²

²¹ Applications appearing as withdrawn in our database could have been pending at the time the application citing them was evaluated since records are continuously updated if legal status changes. The average pendency time for examination (time between filing and grant) at the EPO was around 40.6 months in 2005 and decreasing with respect to previous years (1.9% with respect to 2004, see OECD 2009). Pending status can be associated to several factors: growing complexity and volume of applications, increasing workload at the patent office, strategic delay for request of examination (van Zeebroeck et al. 2009; Harhoff and Wagner 2006).

²² The BEST Programme (“Bringing Examination and Search Together”), initiated in 2000 but actually promoted earlier, might have influenced citation practices at the EPO. This program was basically conceived to improve procedural efficiency and included a series of changes: same examiners doing the searches (for improved

However, we cannot exclude the possibility that applicants might also have increased their use of the patent system for pre-emptive purposes because they knew of these measures and their potential to hinder patenting by others.

We argue that the relative growth of Pure-X withdrawn references may be *partly* due to a more intensive use of patent filings strategically for defensive purposes. If it was a matter of quality, one would expect them to have been cited as relevant to the state of the art so that their high inventiveness would be the cause of their blocking power. But these are patents which have never been deemed relevant to the art, so if they have the strongest pre-emptive power, it means that something other than their technical content is at play, for instance, their strategic positioning (in a patent portfolio; cf. building a picket fence around key inventions) or the way they are drafted. Do they correspond to more costly inventions? Do they have stronger links with scientific knowledge? Are they narrower in scope? Are they filed by firms with large or small patent portfolios? Do pre-emptive withdrawn patent applications indeed have a lower contribution to the art and so, more backward patent citations of type XYE than the rest of patents? Our objective below is to give some answers to these questions.

5.2. Empirical Analysis

Taking the sample of all applications filed by business applicants in the period 1990-2000 and cited in non-pending applications²³ we conduct two probit models to find out whether Pure-

consistency and accelerated examination), the search report (published 18 months after the priority date which, as a rule, means six months after the actual filing date) supplemented by an opinion on patentability, became a full equivalent of the first examiner's communication in current Europe-direct practice (the famous "B10"), or, in Euro-PCT cases; the first preliminary examination communication provided for in Article 33 of PCT. This means that at the earliest possible moment in the grant procedure, applicants and third parties will be in possession of a set of information on which they can rely to build their prosecution and business strategies (Schatz 2004, 166).

²³ Legal status (pending, granted, refused, withdrawn) as of May 2007.

X withdrawn are different from other cited patent applications.²⁴ Table A3 in Annex 2 provides summary statistics for the samples of analysis.

In a first probit model, we estimate the likelihood of being a Pure-X withdrawn patent reference against other references (cited in non-pending applications). In a second probit model, we estimate the likelihood of being a Pure-X withdrawn patent reference against all other references being withdrawn not categorised as Pure-X. Both regressions are run separately for the full sample and for two specific technology areas: chemicals-materials and biotechnology-pharma.²⁵ As we will see, regressions on the full sample show that these fields are the only ones having positive and significant coefficients.

As explanatory variables, we include both characteristics of the patent applications and of their business applicants. First, variables associated to the “scope, cost and scientific content” of the patent: number of claims, number of IPC classes at the four digits level (Lerner 1994), number of inventors (approximating cost of inventions) and the share of non patent literature references in all the backward citations of a patent application (approximating its science linkage). Second, variables associated with the “cumulativeness” of the invention, including number and types of backward patent citations, as well as intensity of self patent references (i.e. share of self patent references in all backward patent citations). As regards types of backward patent references, we include the share of each X, Y and E types of patent references relative to

²⁴ Recall that for identifying the category of Pure-X withdrawn cited applications, we use all forward citations accounted until the last year available in our data (2006), because we use the April 2007 version of PATSTAT. Hence filings made in 2000 have at least six years to be referenced in the search reports of new patent applications. To isolate the effect of pending patents, we have conducted the same probit regressions reported in this section breaking up the period of analysis to cited patents being filed during 1990-1995 and 1996-2000 and the results are quite similar (available upon request).

²⁵ As pointed out by an anonymous referee, the search report may not be completely exogenous to the field. Patent citations are highly technology and time-specific (Hall et al. 2005). To some extent, the search report reflects the dynamics of the technology area. This is one of the motivations to conduct technology level regressions. Testing and correcting for weak exogeneity would demand a more complex modelisation, a system of structural equations taking into account the citation propensity for each individual patent relative to the evolution and composition of the field (patents and quality). This work is beyond the scope of the present paper and should be the object of further research.

the sum of X, Y, E and A patent references [$X/(X+Y+E+A)$; $Y/(X+Y+E+A)$; $E/(X+Y+E+A)$, respectively] as a way to further control for the type of cumulativeness and how much the application in question conflicts with existing patents. According to the theoretical literature on pre-emptive patenting (Gilbert and Newbery 1982; Reinganum 1983), we would expect the likelihood of Pure-X withdrawn applications, which would be related to incremental and low cost inventions, to be higher than that of other cited applications. As regards the scope of the patent application, we may find different profiles, as blocking others may happen with both narrow and broad patents. Broader patents with a pre-emption motivation are deemed to generate “pollution” in the state of the art and therefore confusion in the determination of novelty, whilst narrow patents may be designed to hamper the patentability of a specific competing invention. The intensity of backward patent references of types X, Y and E may not necessarily be a helpful discriminative factor between defensive and actual withdrawals in the second probit, as both defensive and actual withdrawals would be expected to have low degrees of novelty.

Third, two variables related to the “applicant’s portfolio”: portfolio size (number of patent applications accumulated by the end of the previous year), and a dummy controlling for “first time” patentees.²⁶ The dummy on “first time” patentees intends to capture the lack of experience in patenting which might be associated to a higher rate of abandonment (and anticipated rejection). Recall that some of the other variables already control for “quality” attributes of inventions (notably, number of inventors, science linkage, cumulativeness, etc.). On the size of the patent portfolio of patent applicants, using company data on patenting motivations by European companies (EPO Applicant Panel Survey), de Rassenfosse and Guellec (2009) consistently find that companies declaring patenting in order to preserve freedom to operate (defensive) hold larger patent application portfolios. In addition, in line with this rationale of

²⁶ For the construction of patent portfolios we have relied on a preliminary version of the OECD Harmonised Names of Applicants database (HAN), kindly provided by Grid Thoma.

defence, Lanjouw and Schankermann (2001) provide evidence that a larger patent portfolio increases applicants' defence against opposition as it opens new settlement options (e.g. licensing). We expect, then, that business applicants having large patent portfolios would tend to have more strategic patents with defensive motivations: these companies would have more experience in managing and drafting patent rights, and would be more knowledgeable of the surroundings of their technological territory (specialisation).

Further, but only in the second probit, we include the timing of withdrawals (log of the number of days elapsed between first publication of the application at EPO and publication of its withdrawal) as an additional variable that should help us better differentiate defensive from induced withdrawn applications, the latter being anticipated refusals or abandonments due to weak chances to get a grant or limited market prospects. We would expect withdrawals of pre-emptive applications to happen earlier than other types of withdrawals, as applicants seeking a patent grant will naturally tend to stay longer in the patent process. In principle, we could think that defensive patent applications with the sole purpose of disclosure would be dropped immediately after publication. However, it is not so simple to draw the line between defensive and induced withdrawals, as applicants may want to play with pendency, wait until blockade (targeted competitors get their applications refused or withdrawn) and adapt patent strategies accordingly. We should also recall that the costs of staying in the process might be relatively low and applicants can take the chance of having a grant, eventually, if they stay.²⁷

Finally, in both regressions, we control for the impact of having the first applicant residence in the United States, Japan, Germany, France, United Kingdom, Canada, Australia, Switzerland and any other country (the reference category being Canada); and to control for

²⁷ The decision to withdraw early or later in the patenting process will depend on a number of factors including the costs of remaining in the process (and so the financial resources of the applicant) and the chances of getting a grant, considering that at the EPO the highest costs arrive after grant and are related to validation in EPC member states.

differences across technology fields, we rely on the broad technology classes correspondence with IPC classes developed by OST-INPI/FhG and look at patent applications filed in electronics, instruments, chemicals-materials, pharmaceuticals-biotech, industrial processes, machines-mechanics-transport and construction-consumer products (the latter being the category of reference). As for filing years, we consider the period 1990-2000 and take 1990 as the year of reference.²⁸

5.3 Results

In a first regression (**Probit Model 1 in Table 2: Pure-X withdrawn v. other patent references**), we compare the factors affecting the likelihood of being cited as Pure-X and being withdrawn with respect to any other cited patents. Patents cited as conflicting (to others) and being abandoned have significantly fewer claims, fewer inventors, more patent references (in total), a stronger scientific content and a higher self-citation rate than other cited patent applications. This evidence suggests that patent applications with the strongest pre-emptive power may cover “repackaging” inventions: inventions which are mainly a remix of existing art (more backward citations, both from the patent and non patent literature) done at low cost (fewer inventors). Fewer inventors in a patent is associated in the literature with lower cost patented inventions (Gambardella et al. 2008) whereas a higher number of backward patent citations might indicate a stronger cumulativeness (or inter-dependence) of the technology. The coincidence of low inventiveness and high pre-emptive impact supports the idea that some of these patents may be designed defensively by their applicants to strategically block patenting by

²⁸ It would also be possible to control for patent family size, as suggested by one anonymous referee, in order to test whether Pure-X withdrawn patent applications are in families of smaller size than other applications, indicating less willingness to commercialise inventions internationally (if the family includes applications to different patent offices). However, the inclusion of this variable is questionable. In the case a patent is withdrawn from EPO, the family size is ipso-facto reduced. Hence the decision to withdraw defines simultaneously the number of family members. As the validity of prior art is world-wide in scope though, whatever country it has been registered in, this reduced geographical coverage does not hamper the pre-emptive power of the patent application.

others. Further, the United States and United Kingdom are more frequently a source of this type of patent filings which could reflect either a business strategy or a patent attorneys' strategy.²⁹ Pure-X withdrawn also have more citations of a conflicting nature. They have more X, Y and E backward patent references than other cited patents. This result suggests that pre-emptive patent publications of type Pure-X withdrawn have indeed a lower degree of novelty than the rest of patent references.

Some variables have a different marginal effect for chemicals-materials and pharma-biotech (which are the only technological fields in the first regression for all technologies with positive and significant coefficients) than for the total sample regression and between them, indicating that pre-emptive patenting works differently across technology areas. We should note that pharmaceuticals and chemicals are discrete technologies where inventions tend to be substitutes (rather than complementary as in electronics, for instance), incremental innovation is more frequent, and where a single patent can be related to a line of products (Cohen et al. 2002). One important difference is that Pure-X withdrawn applications tend to be filed by applicants with larger patent portfolios in these two sectors, whereas no significant effect is found for the full sample. Also, the number of IPC classes, which had a negative and significant influence for the full sample and was non-significant for chemicals-materials, has a positive and significant impact for pharma-biotech, indicating that Pure-X withdrawn applications tend to have a larger scope in this area.

To take account of the fact that among the Pure-X withdrawn there are patents which might not be strategic but simply low quality patents, in a second regression (**Probit Model 2 in Table 2: Pure-X withdrawn v. other withdrawn patent references**) we attempt to isolate the

²⁹ The investigation on the determinants of unused blocking patents (in the sense of aiming at blocking competitors) based on PATVAL shows that compared to unused sleeping patents, the probability of being in the former group increases for patents whose owner is a company with a United States parent. In terms of technology effects, it is more likely to find patents aimed at blocking in chemicals and pharmaceuticals, given the conditional probability of "unused" patents (European Commission 2006).

characteristics due to low quality in Pure-X withdrawals from the characteristics that might be more related to pre-emption (strategic motivation) by comparing Pure-X withdrawn to other withdrawals (not being cited in this category). The results are quite interesting; controlling for the different attributes reflecting quality (for which we expect no significant differences between the two groups of patents): there is no significant difference in terms of claims, science linkage, number of inventors, or total number of patent references. Yet the Pure-X withdrawn still report a significantly lower number of IPC classes, and contain more patent references of a conflicting nature (in total patent references). Moreover, Pure-X withdrawn tend to be filed by firms with larger patent portfolios and have a higher intensity of self-citation. The latter could be considered as another indication of their strategic nature as one would expect defensive strategies of this kind to be used by more experienced patentees, with large portfolios including patents for inventions building on each other. Furthermore, compared to the rest of withdrawals, Pure-X withdrawn, as expected, are indeed withdrawn earlier. This result is important and indicates that applicants of Pure-X withdrawn applications have a behaviour consistent with pre-emptive intentions; if their sole intention when filing patent applications was to create patent prior art that would hamper the patentability of other applications, they could abandon their applications shortly after their publication (Lazaridis and van Pottelsberghe de la Potterie 2007).

We can say then these patents are intrinsically narrower, possibly because they target very specific domains (lower number of IPC classes), and they are also more likely to come from large patentees than other types of withdrawals. The fact that the ‘first time patentee’ effect is not significant in this model (but was in the first probit) shows that first time patentees tend to withdraw due to lack of experience rather than strategic behaviour, as it is associated with all types of withdrawals, be they Pure-X or not. This is consistent with previous studies on the factors affecting the probability of withdrawal, which has been found to be higher for small and

medium size companies and independent inventors, who might more frequently lack experience in drafting patents and estimating the economic value of inventions (Iversen and Kaloudis 2006; Schettino and Sterlacchini 2009).

We find some differences in the second probit model between the regression of all technologies and the individual ones for chemicals and pharma-biotech (only technological fields with positive and significant marginal effects in the second regression for the full sample). First, the dummy on first time patentees is, as in the total sample, non significant for chemicals-materials, but significant and negative for pharma-biotechnology, indicating that Pure-X withdrawn applications are more likely to be filed by experienced pharma-biotech business applicants. Second, whereas science linkage has a non-significant effect in the full sample and for chemical-materials, it has a positive and significant effect in pharma-biotech. Third, whereas the negative and significant effect of withdrawal lag is present both in the full sample and pharma, it is not significant for chemicals-materials. Lastly, patent self dependence (self-citations) distinguishes defensive withdrawals from other withdrawn patent applications in chemicals-materials significantly more than in biotech and the total sample.

****Table 2 about here****

6. Conclusion

There is compelling anecdotal and survey evidence that some firms use patents to prevent competitors from patenting. Pre-emptive patenting has a double benefit. By creating prior art and raising uncertainty, it prevents the grant of market exclusivity rights to others while providing freedom of operation to its applicant. For these purposes the publication of a patent filing can be enough. There is however limited empirical evidence on how this phenomenon works. This paper provides evidence on pre-emptive patenting using a statistical approach at the patent level to address such question.

Our findings show that pre-emption of patenting by others can occur by filing patents with a minor technical contribution to the art. The filing of patent applications containing trivial inventions to create prior art contributes to raising uncertainty and the patentability threshold for competing inventions. Furthermore, our investigation indicates that companies may file patents to pre-empt competitors from obtaining patent protection in specific technologies or markets without necessarily aiming at getting protection themselves. This novel finding, namely the role of withdrawals, broadens the analysis of patents as strategic instruments and provides empirical statistical evidence compatible with the pre-emptive patenting view stressed in the literature. Consistently with some studies, we show that defensive withdrawals often happen to have a low inventiveness (i.e. fewer inventors) and may be repackaging existing art done at low cost (i.e. more patent and non-patent literature cited in their search reports). They are also abandoned earlier than other types of withdrawn patent applications. Hence, the coincidence of low technical quality and high pre-emptive power supports the idea that some of these applications are designed specifically by their applicants to block strategically competitors. This evidence confirms that, as instruments for defence, pre-emptive patents thus contribute to expanding the flood of patenting.

The effect of pre-emptive patent filings has its positive and its negative sides. Patents can be viewed as a social contract between the patent owner and society, where the price to be paid by the patentee in return for exclusivity is the disclosure of his invention. In the cases we have analysed in this paper, however, applicants see the disclosure of inventions through the patent system not as a cost, but as a benefit. Preventing others from patenting with patent filings that are later withdrawn can result in a patent free area and possibly an effective means to “cut through the patent thicket” in some fields. Hence, defensive patents can be very valuable instruments as

they allow a patent holder to preserve market exclusion and freedom of operation in the exploitation of his technology.

Yet pre-emptive patenting has a direct impact on the working of the patent system. Pre-emptive filings contribute to a kind of arms race and feed patent inflation. Some activity in defensive patenting may constitute an answer to potential offensive patenting. Increasing the backlog of patent offices with filings of dubious technical quality to prevent the grant of other patent applications is nevertheless far from being an efficient way to improve the functioning of the patent system. Our results draw attention to pending applications which are influencing examination of others and are abandoned by their applicant. Proposals have been made regarding the implementation of purifying mechanisms for filings such as the proposition of increasing application fees which could be reimbursed after grant; or the imposition of penalties or rejection of very complex filings (*e.g.* confusing draft of claims).

Lastly, our results call for further research on the effects of pre-emptive patents on firms and markets. First, their effects on R&D investments by companies and innovation are not clear: how do companies react to the foreclosure of entry into patenting? Does their technological trajectory change leading them to invest in R&D in other fields? Second, what are the consequences of these strategies in product markets? These are our next lines of investigation.

REFERENCES

- Arundel, A. and P. Patel. 2003. Strategic patenting. Background Report for the Trend Chart Policy Benchmarking. Paper presented at the European Commission Workshop on New Trends in IPR Policy Luxembourg 3-4 June 2003.
- Bar, T. 2006. Defensive publications in an R&D race. *Journal of Economics and Management Strategy* 15(Spring): 229-254.
- Baker, S. and C. Mezzetti. 2005. Disclosure as a strategy in the patent race. *Journal of Law and Economics* 48: 173-194.
- Blind, K., J. Edler, J., R. Frietsch, and U. Schmoch. 2006. Motives to patent: evidence from Germany. *Research Policy* 35, no. 5: 655-672.
- Ceccagnoli, C. 2009. Appropriability, Pre-emption and Firm Performance. *Strategic Management Journal* 30, no. 1:81-98.
- Cohen, W., A. Goto, A. Nagata, R. Nelson, and J. Walsh. 2002. R&D spillovers, patents and the incentives to innovate in Japan and the United States. *Research Policy* 31, no. 8-9: 1349-1367.
- de Rassenfosse, G. and D. Guellec. 2009. Quality versus quantity: strategic interactions and the patent inflation. Presentation at the 4th EPIP Conference, Bologna.
- Duguet, E. and I. Kabla. 1998. Appropriation strategy and the motivations to use the patent system: an econometric analysis at the firm level in French manufacturing. *Annales d'Economie et de Statistique* 49/50: 289-327.
- European Commission. 2006. *Evaluating the knowledge economy*. Technical Report.
- EPO. 2008. *Applicant Panel Survey 2007 of Intentions for Filing Patent Applications at the European Patent Office and other Offices*. European Patent Office. www.epo.org
- Gambardella, A., D. Harhoff, and B. Verspagen. 2008. The Value of European Patents. *European Management Review* 5, no. 2: 69-84.
- Gilbert, R. and D. Newbery. 1982. Preemptive patenting and the persistence of monopoly. *The American Economic Review* 72, No. 3: 514-526.
- Graham, S. and D. Mowery. 2004. Submarines in software? Continuities in US software patenting in the 1980s and the 1990s. *Economics of Innovation and New Technologies* 13, no. 5: 443-456.
- Graham, S. and D. Harhoff. 2006. Can post-grant reviews improve patent system design? A twin study of US and European patents. CEPR Discussion Papers 5680.
- Greene, W. 2003. *Econometric Analysis*, New Jersey: Prentice Hall.
- Grimpe C. and K. Hussinger. 2008. Pre-empting technology competition through firm acquisitions. *Economics Letters* 100, no. 2: 189-191.

- Guellec, D. and B. van Pottelsberghe de la Potterie. 2000. Applications, grants and the value of patents. *Economics Letters* 69, no. 1: 109-114.
- Hall, B.H. and R.H. Ziedonis. 2001. The patent paradox revisited: an empirical study of patenting in the US semiconductor industry 1979-1995. *Rand Journal of Economics* 32, no. 1: 101-128.
- Hall, B., A. Jaffe and M. Trajtenberg. 2005. Market Value and Patent Citations. *Rand Journal of Economics* 36: 16-38:
- Harhoff, D. and B.H. Hall. 2003. Intellectual Property Strategy in the Global Cosmetics Industry. http://elsa.berkeley.edu/~bhhall/IP%20Cosmetics_NBER02.pdf
- Harhoff, D., F. Narin, F.M. Scherer, and K. Vopel. 1999. Citation Frequency And The Value of Patented Inventions. *The Review of Economics and Statistics* 81, no. 3: 511-515.
- Harhoff, D. and M. Reitzig. 2004. Determinants of opposition against EPO patent grants – the case of biotechnology and pharmaceuticals. *International Journal of Industrial Organisation* 22: 443-480.
- Harhoff, D., F.M. Scherer, and K. Vopel. 2003. Citations, family size, opposition and the value of patent rights. *Research Policy* 32, no. 8: 1343-1363.
- Harhoff, D., G. von Graevenitz, and S. Wagner. 2008. Incidence and growth of patent thickets – the impact of technological opportunities and complexity. CEPR Discussion Paper 6900.
- Harhoff, D. and S. Wagner. 2006. Modeling the Duration of Patent Examination at the European Patent Office. Discussion Papers in Business Administration 1256, University of Munich, Munich School of Management.
- Hausman, J. and D. McFadden. 1984. Specification Tests for the Multinomial Logit Model. *Econometrica* 52, no. 5:1219-1240.
- Henkel, J. and S. Pangerl. 2008. Alternatives to the patent arms race: an empirical study of defensive publishing. May. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=981444
- Iversen, E. and A. Kaloudis. 2006. IP-valuation as a tool to sustain innovation. STEP Report Series 199615. The Step Group, Studies in Technology, Innovation and Innovation Policy. Norway.
- Lanjouw, J.O. and M. Schankerman. 2001. Characteristics of Patent Litigation: A Window on Competition. *The Rand Journal of Economics* 32, no. 1: 129-51.
- Lanjouw, J.O. and M. Schankerman. 2004. Patent Quality and Research Productivity: Measuring Innovation with multiple indicators. *The Economic Journal* 114: 441-465.
- Lazaridis G. and B. van Pottelsberghe de la Potterie. 2007. The rigour of EPO's patentability criteria: an insight into the 'induced withdrawals'. *World Patent Information* 29, no. 4:317-326.
- Lerner, J. 1994. The importance of patent scope: an empirical analysis. *RAND Journal of Economics* 25, no. 2: 319–333.
- Michel, J. and B. Bettels. 2001. Patent citation analysis. *Scientometrics* 51, no. 1: 185-201.

OECD. 2009. *OECD Patent Statistics Manual*.

Reinganum, J. 1983. Uncertain innovation and the persistence of monopoly. *The American Economic Review* 73, no. 4: 741-748.

Roland Berger Market Research. 2005. Study on the Cost of Patenting in Europe, www.epo.org

Schatz, U. 2004. Recent changes and expected developments in patent regimes: a European perspective, in *Patents, Innovation and Economic Performance*, Chapter 8, 163-172. Paris: OECD.

Schneider, C. 2007. The determinants of patent application outcomes – does experience matter? CEBR Discussion Paper 2007/12, Center for Economic and Business Research, Copenhagen Business School.

Schneider, C. 2008. Fences and competition in patent races. *International Journal of Industrial Organization* 26, no. 6: 1348-1364.

Shapiro, C. 2006. Injunctions, hold up and patent royalties. http://works.bepress.com/carl_shapiro/10

Schettino, F. and A. Sterlacchini. 2009. Determinants of patent withdrawals: Evidence from a sample of Italian applications with the EPO. *World Patent Information* 31, no.4: 308-314.

Stevnsborg, N. and B. van Pottelsberghe de la Potterie. 2007. Patenting procedures and filing strategies at the EPO. in *The Economics of the European Patent System*. ed. Guellec, D. and B. van Pottelsberghe de la Potterie, Chapter 6, 155-183. Oxford: Oxford University Press.

van Looy, B., M. du Plessis and T. Magerman. 2006. Data production methods for harmonised patent indicators: assignee sector allocation. EUROSTAT Working Paper and Studies. Luxembourg.

van Zeebroeck, N. and B. van Pottelsberghe de la Potterie. 2008. Filing Strategies and Patent Value. CEPR Discussion Papers 6821.

van Pottelsberghe de la Potterie, B. and D. François. 2009. The Cost Factor in Patent Systems. *Journal of Industry, Competition and Trade* 9, no. 4: 329-355.

van Zeebroeck, N., B. van Pottelsberghe de la Potterie and D. Guellec. 2009. Claiming more: the increased voluminosity of patent applications and its determinants. *Research Policy* 38, no. 6: 1006-1020.

Webb, C., H. Dernis, D. Harhoff, and K. Hoisl. 2005. Analysing European and International Patent Citations: A Set of EPO Patent Database Building Blocks. OECD Science, Technology and Industry Working Papers 2005/9.

Vickers, J. 1985. Pre-emptive patenting, joint ventures, and the persistence of oligopoly. *International Journal of Industrial Organization*, 3, no. 3: 261-273.

ANNEX 1: Information from Patent References

Patent examiners classify relevant prior art in order to characterise the novelty and inventive step of the claimed invention. This categorisation is our point of reference to identify and evaluate the pre-emptive power of patent references. Citation categories X, Y and E apply to prior patent filings compromising the novelty and patentability of new applications, whereas citation category A corresponds to patent references that are relevant to the state of the art (see Table A1). The system of citation categories is generally only used by the EPO and by PCT international search authorities (ISA).³⁰ Other large patent offices, such as the USPTO, use it in their international preliminary search reports when they act as ISA, but not for their internal examination procedures.

Table A1. Citation categories in EPO and PCT search reports

Category	Meaning
X	Particularly relevant documents when taken alone (a claimed invention cannot be considered novel or cannot be considered to involve an inventive step)
Y	Particularly relevant documents if combined with one or more other documents of the same category such a combination being obvious to a person skilled in the art
E	Potentially conflicting documents – any patent document bearing a filing or priority date earlier than the filing date of the application searched but published later than that date, and the content of which would constitute prior art
A	Documents defining the general state of the art (but not belonging to X or Y)

Source: European Patent Office Guidelines for Examination, 2007.

Patent references cited under the X citation category would be the most important ones to invalidate the novelty or inventiveness of one or more claims within a patent application. If the search report of an application includes a patent reference categorised as X associated to a particular claim or number of claims, it means that the application does not meet the requirements of novelty or inventive step with respect to that claim or claims. After receiving the search report, the applicant could withdraw the application in view of an anticipated refusal, or revise those claims in an attempt to obtain patent protection for other parts of his invention, or proceed with the application without changing anything, hoping that he will get a grant regardless of the unfavourable prior art search report. Type E references are equivalent to type X references, the only difference between the two being a question of time, with E references referring to patent filings which have been published after the filing of the application for which the prior art search report is being done. Type Y patent references, when taken together or in

³⁰ The PCT is an international patent law treaty that provides the possibility to seek patent rights in a large number of countries (contracting states of the treaty) by filing a single international application (PCT application) with a single patent office (receiving office). PCT applications do not result in the issuance of “international patents”. The decision on whether to grant or reject patent rights rests with national or regional patent offices. PCT applications are administered by the World Intellectual Property Organization (WIPO).

conjunction with other references, may have the same effect, but less directly so.³¹ In turn, type A references merely provide technical background information. In Annex I we report more details about the definition of our sample of EP patent filings.

We have restricted our analysis to patents with search reports prepared by EPO examiners (for EPO direct and PCT filings at EPO) to ensure homogeneity of criteria for identifying conflicting citations.³² In order to have information on the procedural status of the cited application, we have replaced non-EP patent citations with their EP-equivalents (if they do not have an EP-equivalent, they are excluded) and limited our econometric study to EP to EP citations and to EP to non-EP citations whenever the non-EP application cited had an EP equivalent. In the latter case we considered the citation category assigned to the non-EP application cited originally, but considered the procedural status and main IPC class of its equivalent filing at EPO. We combined, avoiding duplications, EPO citations (X, Y, E or A) from EPO and PCT search reports for completeness. The EPO-direct and PCT search reports of each patent application tend to be done by the same examiner at EPO who then does not usually compile all references in a single document, so that a full list of references is best obtained by combining citations from the PCT and EPO reports (see Webb et al. 2005).

³¹ The decision to grant or reject a patent application is taken on the basis of the references given to prior art reflecting not “the complete profile of prior art” but “the closest and most relevant prior art” (see EPO guidelines for examiners): One X or two Y are enough to invalidate at least one claim, possibly more.

³² As said earlier, other patent offices use citation categories to prepare international preliminary search reports when acting as ISA (International Search Authority), but not for their internal examination processes, so EPO search reports are the only ones permitting this kind of analysis. It remains a task for further research to estimate and quantify the pre-emptive activity associated to non-EP patents. At the EPO, referencing seeks to use the earliest and most easily available “incarnation” of an invention, preferably in the language of the applicant (OECD 2009). However, a patent (application or grant) can be cited as a national publication or international/regional, or as one of its equivalents (in a patent family; e.g. a filing with same priority at the EPO, USPTO, JPO).

ANNEX 2. Defensive Patenting v. Defensive Publishing

Defensive patenting can be compared with other types of disclosures such as publishing inventions using commercial disclosure services or specialised journals, as both aim to generate prior art and can be then used to destroy novelty in subsequent inventions that are patented.³³

However, defensive patenting and defensive publication (through commercial disclosure services and journals) differ in several aspects. Defensive publication through means other than patents is made more attractive when an invention is clearly not patentable and/or if it appears unlikely that having a patent would increase the value of the invention sufficiently to recoup the cost of patenting. Defensive publication is markedly less demanding technically than applying for a patent but its legal recognition is however less widespread.

In terms of methodology, it is much harder to identify defensive publication. There is no database gathering defensive publication activity. It would be possible to identify references to non patent prior art related to research disclosures and journals (non patent prior art catalogued as PCT Minimum Documentation). However, this data is limited for research purposes, as in some cases, disclosures are anonymous and there is no well defined field of technology. Further, the universe of defensive publications (aiming to deter patenting) would be hard to establish (which journals or disclosure services should be considered and how to identify publishing by a firm when some publications are anonymous or are difficult to attribute to a firm).

It is also true that drafting a patent is usually more costly than describing a technical disclosure; it requires a combination of technical and legal expertise at a cost which needs to be incurred in addition to patent filing fees and other related costs. Yet patents have distinctive features that make them more attractive compared to other means traditionally used for defensive disclosures : i) the use of patent prior art is more harmonised across countries than non patent prior art; evidentiary requirements regarding publications other than patents vary more substantially between jurisdictions;³⁴ ii) drafting claims in a patent application is a more effective way to define (and defend) the scope of an invention in legal terms than describing them in a journal; iii) using patent filings to disclose inventions (and as long as the patent application is pending) keeps the possibility open for the applicant to obtain patent protection on those inventions (if patentability criteria are accomplished and the intended patents are eventually granted); whereas defensive publishing outside the patent system (e.g. in journals, internet, etc) destroys the

³³ Two examples of commercial defensive Publishing services are www.researchdisclosure.com and www.ip.com. They present themselves as a low cost alternative to patents for disclosing prior art with the aim to prevent others from patenting the same inventions. In turn, the IBM Journal of Technical Disclosures, published between 1958 and 1998, is one example of a journal issued by a firm to disclose its own inventions.

³⁴ Unless an applicant understands exactly what evidence of publication is required by which tribunal, it is recommended to use recognised research disclosure services or journals, checking that the service or journal has PCT Minimum Documentation Status.

novelty of an invention and thus prevents patenting (or raises the patentability threshold) for all, including the inventor himself; iv) the patent applicant can use the “pending patent” condition to his advantage from the moment of filing (e.g. trying to signal that he has a large likelihood of getting a grant and may thus be able to claim damages in the future if there is infringement); v) patent applications are the most visible type of prior art to patent examiners; vi) patent filings have an incontestable time stamp providing a clear date of priority for the invention; vii) the contribution to prior art is done when the application is published, usually 18 months after filing, frequently long before its examination is completed or even started, and irrespectively of the application being withdrawn or pursued to the end (the applicant can withdraw or abandon the patent application); and viii) filing fees represent a very small share of the full costs associated to getting patent protection. At EPO, the lion’s share corresponds to the cost of validating protection at the national level after grant. A recent survey shows that more than half of the costs to get a European patent (56% of 31,580 Euros for a Euro-direct patent) are related to validation, translation, national fees and other costs associated with getting protection in the designated European states once the patent has been granted at EPO (Roland Berger Market Research 2005; van Pottelsberghe de la Potterie and François 2008).

ANNEX 2

Table A2. Multinomial logit models: Summary statistics of citing patent applications

Non-pending as of May 2007. Filing years 1990-2000

Patent references	All Non pending	Granted	Withdrawn	Refused
	Mean	Mean	Mean	Mean
X	0.29	0.26	0.35	0.28
Y	0.21	0.19	0.23	0.21
E	0.02	0.02	0.02	0.02
A	0.71	0.74	0.64	0.71
X/Y/E of Pure-X	0.19	0.16	0.24	0.18
X/Y/E of X&A	0.34	0.32	0.39	0.35
A of X&A	0.46	0.48	0.41	0.46
A of Pure-A	0.38	0.39	0.34	0.38
X/Y/E of Pure-X granted	0.13	0.12	0.15	0.12
X/Y/E of Pure-X withdrawn	0.06	0.05	0.09	0.06
X/Y/E of Pure-X refused	0.01	0.01	0.01	0.02
X/Y/E of Pure-X pending	0.00	0.00	0.00	0.00
X/Y/E of X&A granted	0.26	0.25	0.28	0.26
X/Y/E of X&A withdrawn	0.09	0.08	0.12	0.10
X/Y/E of X&A refused	0.02	0.02	0.02	0.02
X/Y/E of X&A pending	0.01	0.01	0.01	0.00
A of X&A granted	0.36	0.39	0.31	0.35
A of X&A withdrawn	0.12	0.11	0.12	0.13
A of X&A refused	0.02	0.02	0.02	0.03
A of X&A pending	0.01	0.01	0.01	0.00
A of Pure-A granted	0.28	0.30	0.24	0.27
A of Pure-A withdrawn	0.11	0.11	0.12	0.12
A of Pure-A refused	0.02	0.02	0.02	0.02
A of Pure-A pending	0.00	0.00	0.00	0.00
US applicant	0.31	0.27	0.38	0.39
Japan applicant	0.18	0.20	0.13	0.15
Germany applicant	0.19	0.21	0.16	0.16
France applicant	0.07	0.08	0.06	0.07
UK applicant	0.05	0.04	0.05	0.06
Australia applicant	0.01	0.00	0.01	0.01
Canada applicant	0.01	0.01	0.01	0.01
Switzerland applicant	0.03	0.04	0.03	0.03
Other countries applicant	0.15	0.15	0.16	0.14
Electronics	0.23	0.21	0.25	0.24
Instruments	0.17	0.17	0.18	0.17
Chemicals-materials	0.18	0.19	0.18	0.22
Pharmaceuticals-biotech	0.06	0.05	0.08	0.06
Industrial processes	0.19	0.20	0.17	0.18
Machines, mechanics, transport	0.10	0.11	0.08	0.09
Construction-consumer products	0.06	0.06	0.07	0.05
Filing year 1990	0.07	0.08	0.07	0.10
Filing year 1991	0.08	0.08	0.06	0.10
Filing year 1992	0.08	0.09	0.07	0.11
Filing year 1993	0.09	0.09	0.07	0.12
Filing year 1994	0.09	0.09	0.08	0.11
Filing year 1995	0.09	0.10	0.08	0.11
Filing year 1996	0.10	0.10	0.09	0.11
Filing year 1997	0.10	0.10	0.11	0.09
Filing year 1998	0.11	0.10	0.12	0.07
Filing year 1999	0.10	0.09	0.12	0.04
Filing year 2000	0.09	0.08	0.12	0.03
Number of observations	425582	274207	136440	14935

Table A3. Summary statistics probit models: Pure-X withdrawn v. Other references

Patent references filed in 1990-2000 and cited in non-pending applications up to end 2006

	Pure-X withdrawn				Other patent references not Pure-X withdrawn				Other withdrawn patent references not Pure-X			
	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max	Mean	Std. Dev	Min	Max
Number of claims	14.873	11.201	0	196	13.892	10.685	0	395	14.393	11.394	0	327
Number of IPC classes	2.095	1.277	1	11	2.004	1.177	1	16	2.020	1.174	1	12
Number of inventors	2.545	1.768	1	20	2.528	1.742	1	32	2.425	1.705	1	28
Science linkage	0.178	0.253	0	1	0.145	0.224	0	1	0.164	0.245	0	1
Number of patent references	4.365	2.904	0	43	4.404	2.722	0	50	4.322	2.914	0	45
Share of X patent references	0.277	0.344	0	1	0.196	0.305	0	1	0.239	0.325	0	1
Share of Y patent references	0.172	0.288	0	1	0.145	0.268	0	1	0.163	0.279	0	1
Share of E patent references	0.016	0.095	0	1	0.007	0.056	0	1	0.009	0.065	0	1
Share of A patent references	0.534	0.388	0	1	0.651	0.372	0	1	0.587	0.379	0	1
Self patent reference intensity	0.067	0.170	0	1	0.061	0.159	0	1	0.059	0.158	0	1
Patent portfolio	1076.153	2285.001	0	17558	1064.889	2215.649	0	17558	1092.805	2284.229	0	17558
First time patentee	0.129				0.109				0.140			
Days to withdrawal	1257.319	671.815	14	5516					1254.051	692.028	0	5663
US applicant	0.435				0.337				0.444			
Japan applicant	0.164				0.204				0.148			
Germany applicant	0.142				0.183				0.144			
France applicant	0.040				0.060				0.045			
UK applicant	0.057				0.044				0.053			
Australia applicant	0.004				0.004				0.005			
Canada applicant	0.010				0.010				0.010			
Switzerland applicant	0.028				0.034				0.028			
Other countries applicant	0.120				0.125				0.123			
Electronics	0.227				0.241				0.278			
Instruments	0.155				0.161				0.171			
Chemicals-materials	0.226				0.189				0.180			
Pharmaceuticals-biotech	0.117				0.054				0.056			
Industrial processes	0.148				0.191				0.168			
Machines, mechanics, transport	0.071				0.106				0.086			
Construction-consumer products	0.057				0.058				0.061			
Number of observations	15377				188881				36062			

FIGURES AND TABLES IN MAIN TEXT

Figure 1. The process of pre-emptive patenting

Source: Own elaboration.

Figure 2. Growth of Pure-X withdrawn patent references

Filing years 1990-2000

Source: Own elaboration based on data from PATSTAT, April 2007

Table 1. Multinomial logit model on outcomes of EPO non pending citing patent applications with respect to types of cited patent references

Filing years of citing patent applications: 1990-2000

Patent references	MNL 1				MNL 2			
	Citation profile				Citation profile and procedural status			
	Refusal		Withdrawal		Refusal		Withdrawal	
	Marginal Effect	(S.E.)	Marginal Effect	(S.E.)	Marginal Effect	(S.E.)	Marginal Effect	(S.E.)
X/Y/E of Pure-X	0.0008	(0.0007)	0.0741 ***	(0.0021)				
X/Y/E of X&A	-0.0012 *	(0.0006)	0.0388 ***	(0.0018)				
A of X&A	-0.0017 ***	(0.0006)	-0.0351 ***	(0.0017)				
A of Pure-A	0.0001	(0.0006)	-0.0178 ***	(0.0017)				
X/Y/E of Pure-X granted					0.0005	(0.0008)	0.0358 ***	(0.0023)
X/Y/E of Pure-X withdrawn					-0.0017	(0.0011)	0.1194 ***	(0.0033)
X/Y/E of Pure-X refused					0.0176 ***	(0.0033)	0.0746 ***	(0.0079)
X/Y/E of Pure-X pending					0.0054	(0.0070)	0.0967 ***	(0.0143)
X/Y/E of X&A granted					-0.0026 ***	(0.0006)	0.0114 ***	(0.0018)
X/Y/E of X&A withdrawn					0.0022 **	(0.0009)	0.0770 ***	(0.0027)
X/Y/E of X&A refused					0.0068 ***	(0.0021)	0.0589 ***	(0.0056)
X/Y/E of X&A pending					-0.0039	(0.0036)	0.0483 ***	(0.0093)
A of X&A granted					-0.0026 ***	(0.0006)	-0.0505 ***	(0.0016)
A of X&A withdrawn					0.0018 **	(0.0008)	0.0134 ***	(0.0024)
A of X&A refused					0.0029 *	(0.0017)	0.0037	(0.0048)
A of X&A pending					0.0014	(0.0043)	0.0055	(0.0092)
A of Pure-A granted					-0.0007	(0.0006)	-0.0370 ***	(0.0017)
A of Pure-A withdrawn					0.0020 **	(0.0009)	0.0242 ***	(0.0024)
A of Pure-A refused					0.0031	(0.0019)	0.0112	(0.0053)
A of Pure-A pending					0.0016	(0.0078)	0.0196	(0.0158)
Applicant countries	Yes		Yes		Yes		Yes	
Filing years	Yes		Yes		Yes		Yes	
Technology areas	Yes		Yes		Yes		Yes	
Observations	425582				425582			
Wald χ^2	20802.02				22782.58			
Log pseudolikelihood	-314673.89				-313540.99			

Note: (S.E.) stands for standard errors. Base outcome is “granted”. Marginal effects of dummy variables are for discrete changes from 0 to 1 (all independent variables are dummies). ‘Pure-X’ are filings which have only been cited (up to end 2006) as either X, Y or E; ‘X and A’ are filings which have been cited as X, Y or E and A; and ‘Pure-A’ are filings which have only been cited as A. Robust standard errors in parentheses (S.E.).

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2. The probit model on the likelihood of pre-emptive filings
Patent references with filing years 1990-2000 cited in non pending patents (marginal effects)

	PROBIT 1: 'Pure-X withdrawn' v other patent references			PROBIT 2: 'Pure-X withdrawn v. other withdrawn patent references		
	All	Chemicals-materials	Pharma-biotechnology	All	Chemicals-materials	Pharma-biotechnology
Scope, cost and scientific content:						
Number of claims (log)	-0.003*** (0.001)	0.000 (0.003)	-0.005 (0.006)	0.004 (0.004)	-0.005 (0.01)	0.001 (0.018)
Number of IPC (log)	-0.004** (0.002)	-0.005 (0.004)	0.023** (0.010)	-0.022*** (0.007)	-0.024 (0.015)	0.014 (0.028)
Number of inventors (log)	-0.009*** (0.001)	-0.004 (0.004)	-0.015* (0.009)	-0.009 (0.006)	0.006 (0.013)	-0.03 (0.025)
Science linkage	0.026*** (0.003)	0.021*** (0.008)	0.114*** (0.016)	0.019 (0.013)	0.024 (0.028)	0.164*** (0.044)
Cumulativeness:						
Number of patent references (log)	0.006*** (0.001)	0.006 (0.003)	0.006 (0.009)	0.006 (0.006)	-0.014 (0.013)	0.021 (0.023)
Share of X patent references	0.046*** (0.002)	0.049*** (0.004)	0.067*** (0.010)	0.049*** (0.007)	0.035** (0.015)	0.059** (0.027)
Share of Y patent references	0.031*** (0.002)	0.028*** (0.005)	0.053*** (0.011)	0.041*** (0.008)	0.021 (0.019)	0.059* (0.031)
Share of E patent references	0.095*** (0.007)	0.131*** (0.018)	0.203*** (0.024)	0.157*** (0.028)	0.193*** (0.060)	0.26*** (0.064)
Self patent references intensity	0.006*** (0.001)	0.006 (0.003)	0.006 (0.009)	0.045*** (0.014)	0.1*** (0.026)	0.036 (0.051)
Applicant's portfolio:						
Portfolio size (log)	-0.000 (0.000)	0.004*** (0.001)	0.003** (0.002)	0.002** (0.001)	0.002 (0.003)	0.001 (0.005)
First time patentee (dummy)	0.012*** (0.002)	0.027*** (0.009)	-0.017 (0.013)	-0.002 (0.008)	-0.005 (0.026)	-0.064* (0.038)
Timing of withdrawal:						
Days from pub. to withdrawal (log)				-0.011*** (0.004)	-0.007 (0.009)	-0.042** (0.017)
Country, technology, filing years:						
US applicant	0.02 ***	0.015	0.011	0.005	-0.058	0.052
Japanese applicant	-0.007	-0.018	-0.021	0.042*	-0.051	0.105
German applicant	-0.005	-0.016	-0.038	0.013	-0.089	0.031
French applicant	-0.012**	-0.026*	-0.09***	0.001	-0.136**	-0.002
UK applicant	0.021***	0.025	-0.015	0.04	-0.01	0.09
Australian applicant	0.012	0.029	-0.061*	0.023	0.004	-0.069
Swiss applicant	-0.004	-0.006	-0.064**	0.015	-0.052	-0.027
Applicant from other countries	0.002	-0.011	-0.034	0.009	-0.084	0.049
Electronics	-0.007***			-0.042***		
Instruments	-0.006**			-0.018*		
Chemicals-materials	0.011***			0.053***		
Pharmaceuticals-biotech	0.041***			0.154***		
Industrial processes	-0.014***			-0.019*		
Machines, mechanics, transport	-0.022***			-0.034***		
Filing years	yes	yes	yes	yes	yes	yes
Observations	185901	35005	9120	42644	8159	2661
Wald χ^2	3518.68	595.32	461.98	1390.28	254.78	125.37
Pseudo R ²	0.0360	0.0296	0.0671	0.0270	0.0242	0.0361
Log Pseudo likelihood	-46716.02	-9965.47	-3487.80	-25436.71	-5169.47	-1774.85

Note: Marginal effects for dummy variables are for discrete changes from 0 to 1. 'Pure-X' filings have only been cited as X, Y or E, never as A (up to end 2006) Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%