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Financial patenting in Europe

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Abstract

We take a first look at financial patents at the European Patent Office (EPO). As is the case at the United States Patent and Trademark Office, the number of financial patents in Europe has increased significantly in parallel with significant changes in payment and financial systems. Scholars have argued that financial patents, like other business methods patents, have low value and are owned for strategic reasons rather than for protecting real inventions. We find that established firms in non-financial sectors with diversified patent portfolios own a large share of financial patents at the EPO. However, new specialized technology providers in the financial area also hold a number of such patents. Decisions on the financial patent applications take longer and they are more likely to be refused by the patent office, suggesting greater uncertainty over validity than for other patents. They are also more likely to be opposed, which is consistent with the fact that their other economic value indicators are higher.

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Introduction

The advent and fast growth of the Internet economy has been accompanied by innovation in traditional forms of financial payments. These changes have been propelled on the one hand by the emergence of new commercial relations conveyed through the Internet, which require new and secure modes of payments – for example, digital marketplaces and e-commerce. On the other hand, traditional markets and industries have experienced the diffusion of new business practices within their procurement and marketing activities (Tufano, 2003; Lerner, 2004).

The potential benign impact of innovation in the payment and financial systems is very high and extends well beyond the banking sector. It is worth remembering that changes in the short-term payment and financial systems were at the base – among others – of the commercial revolution in Europe during the 15th and 16th centuries (Rosenberg and Birdzell, 1986). The relationship between the development of an economy's financial structure – financial instruments, markets, and institutions – and economic growth in the modern economy is well documented in the literature (Levine, 1997). More recently, scholars have suggested that innovation in payment and financial systems has some of the features of a General Purpose Technology (GPT) (Hall, 2007). GPTs are technologies characterized by use in a wide range of sectors, the need for complementary investment when adopted, and scope for productivity enhancement in diverse sectors of the economy, leading to increasing returns on both the supply and demand side (Bresnahan and Trajtenberg, 1995).

Here, as in most areas, the strengthening of patent coverage can have both positive and negative effects. On the one hand, it can increase the incentive to devote resources to inventive activity. On the other hand, it may discourage or raise the cost of combining and re-combining of inventions to make new products and processes, in particular in cumulative innovations such as GPTs and technologies that are part of a standard setting process (see, among others, Scotchmer, 1996; Cohen and Lemley, 2001; Lemley, 2007). Q4 These considerations are of particular relevance for financial patents and software and business methods in general (Hall, 2003) due to the importance of standards for technologies enabling web-based interactions and financial transactions, whether conducted via the web or over other telecommunications networks.

Patenting in this area has increased significantly in the last two decades. According to evidence documented by Hall (2007), 5393 patents were issued by the United States

Patent and Trademark Office (USPTO) in Class 705 (Data Processing: Financial, Business Practice, Management, or Cost/Price Determination) during the decade 1995–2004, corresponding to approximately 2918 patentees. Patenting in this class accelerated after the key decisions taken by the Courts of Appeals for the Federal Circuit (CAFC) in 1998, which removed most of the exceptions to the patentability of software and other business methods 'as such,' that is, methods that are independent of a particular physical embodiment (State Street v. Signature Financial Group 1998, ATT v. Excel Communications 1998). Such patents have proved particularly contentious and subject to litigation, especially those related to financial innovations. For example, Lerner (2006) reported a litigation rate on financial patents 27 times larger than the rate found by Lanjouw and Schankerman (2001) for a sample of all patents.

Even in the US, the question of exactly what types of software or business methods may be patented remains controversial. Recently, prompted by a series of Supreme Court decisions, the CAFC decided to reconsider the question of patentable subject matter by scheduling an *en banc* hearing (before all judges of the Court) to consider an appeal *in re* Bilski.[1] A decision was issued on October 30, 2008. This decision is viewed as restricting business method and financial patenting at the USPTO to some extent Q5 (Managing Intellectual Property, 2008b). In particular, the court found that if an invention relates to a 'pure' business method that is not limited to performance on a computer and produces only abstract results such as manipulation of documents, information, or data, it is not a patentable subject matter. Moreover the USPTO has already issued clarifying guidelines with respect to business methods (May 15, 2008) and a reform of the patent system is debated at the US Congress.

At the European Patent Office (EPO) the treatment of software and intangible business methods is different, with these inventions excluded 'as such' from patentable subject matter according to the European Patent Convention (Article 52). Nevertheless, when we analyzed a large data set of EPO patents, we found an increasing number of what appeared to be software-related patents during the 1990s (Hall *et al*., 2007). This suggests that, despite the different legal environment, barriers to patenting on software and intangible business methods may have fallen somewhat in Europe as well. This process has been reinforced by some conflicting decisions at the various national European courts and the European Court of Justice. An attempt to clarify EPO practice is currently underway (Managing Q6 Intellectual Property, 2008b).

Another notable difference between the two patent systems, US and European, concerns the process for post-grant validity challenges. The US system has two main ways to challenge validity: *ex-parte* re-examination available to anyone, and litigation over validity, which can only be initiated by a party that has been accused of infringement.[2] The EPO system relies on an *inter-partes* opposition system that allows third parties to actively provide evidence of prior art that may have been missed during the examination process. Oppositions can be filed by any party at the EPO within 9 months after the patent is granted; in practice, they are generally filed on the last eligible day. The input provided by third-party oppositions complements the pre-grant search process conducted by the EPO, especially in new subject matter areas such as software and business methods, where information on prior art is not easily accessible to patent examiners (Janis, 1997; Hall, 2003). As in the US, opposition may or may not be followed by litigation, but in this case, the jurisdiction shifts to national courts rather than being European-wide, which makes it a somewhat less attractive option for invalidating a patent.

In the USPTO context the heterogeneity of the actors involved in financial patents can be seen along a number of dimensions (Hall, 2007). About 20% of the patentees are alliances or R&D consortia of financial firms, suggesting the importance of the standards setting process in payment and financial systems. Other patentees are older and larger firms active in non-financial and non-software sectors such as oil and gas or machinery. Newer patentees are typically small firms and only three of them – E-Trade, eBay, and Verisign – have more than one billion dollars of revenue annually by 2005. Another dimension of heterogeneity is the importance of financial patents relatively to the overall portfolio of the patentee: only 0.7% of patents in this class are granted to firms that specialize in financial patenting, whereas the remaining patents are held by large patentees that operate in a number of other sectors such as Exxon Mobil, Chevron, NCR, Lockheed Martin, Diebold, etc. This picture is quite similar to that of software-related patents, a large proportion of which are held by non-software firms. The small share of patents held by financial institutions in the US is at odds with the importance of these institutions in the creation of financial innovations (Tufano, 2003). Moreover, patent holding firms specialized in licensing and litigating patent awards are the most frequent plaintiffs in patent litigations, whereas financial innovators (investment banks, trading exchanges, and other financial institutions) are mostly involved as defendants (Lerner, 2006).

Based on this body of evidence, scholars have raised concern about the growing number of financial and business method patents whose average quality is considered low because of the limited examination capacity of the US patent office, the lack of prior art databases (both patent and non-patent literature), and a declining severity of the non-obviousness test in court decisions. Several authors have then suggested that the standard of patentability should be raised especially in subject matters like software and business methods (Barton, 2000; Dreyfuss, 2001; Lunney, 2001; Hall, 2007; Bessen and Meurer, 2008). The CAFC decision in light of the Bilski case and the USPTO clarifying guidelines with respect to business methods may prelude to future potential changes in the patenting rules, which add further uncertainty to the uncertainty arising from the ambiguous claims and unclear definition of the boundaries of financial patents and other business method patents. This ambiguity may slowdown the investments on innovation because of hold-up problems that are especially important in the case of sequential innovations, a high risk of involuntary infringement, and high litigation costs (Bessen and Meurer, 2008; Hunt, 2008).

Following on the results for the US, in this paper we look at the ways in which firms in Europe are dealing with the increase of financial patenting, given the differences they face in patentability in their home markets.

The differences between US and European patenting systems – such as (possibly) more thorough search of prior art, the exclusion of software and business methods ‘as such’ from the patentable subject matter, and the opposition system – offer a fertile ground for examining the ways in which firm patenting strategy reacts to different institutional incentives.

In this context, the following exploratory questions drive our empirical research.

- How can we define financial patents at the EPO and how many are issued, given the definition?
- Which firms obtain financial patents? What are their characteristics – sector, size, age, listed *vs* non-listed, the size of their patent portfolio?
- Do non-financial firms own a large share of these patents, as in the US?
- How do financial patents differ from other patents in their scope, citation of patent and non-patent literature, forward and backward citations, family size, and other characteristics?
- Are European firms patenting financial innovations at the USPTO? How many also succeed at the EPO? That is, what is the pattern of equivalents?

Our paper contributes to the literature on the economics and management of patents in ways discussed below. First, while a growing body of evidence has focused on business method patents in the US system, the analysis of business methods patents in Europe is still in its infancy (e.g., Wagner, 2008). Moreover, to the best of our knowledge, this is the first study to focus on financial patents in the European context. Looking at financial patenting in particular is important because business methods encompass a highly heterogeneous set of technological and ‘intellectual’ innovations. When aggregating such different types of innovations one runs the risk of overlooking important peculiarities of innovation and patenting strategy in the financial sector.

Second, the patent literature distinguishes between patent quality and economic value or importance of patents. Patent quality refers to the statutory definition of a patentable invention – novelty, non-obviousness, and usefulness (or the production of a technical effect). Moreover, to be patentable an application must disclose sufficient information about the invention. The economic value of a patent depends on the expected profits accruing to its owner. Earlier studies have found that litigation and opposition are correlated with various indicators of patent value or importance (Harhoff *et al*., 2003; Harhoff and Reitzig, 2004; Lerner, 2006). Therefore, we estimate probit models for the probability of a decision by the EPO conditional on an application, a grant conditional on a decision, and an oppositions conditional on a grant that are similar to those in the literature, but focusing on our sample of financial patents.

The paper is organized as follows. The next section describes the background literature and sets out some research hypotheses. The subsequent section describes the data while the section after that reports the results of the empirical analysis that compares financial patents to other patents and the penultimate section presents an analysis of the outcomes at the EPO for financial patent applications. The final section concludes.

Background and hypotheses

To understand the quality and value of financial patents we need to clarify the peculiarities of financial innovations and to link these peculiarities to the economics of patenting. The main social function of the patent system is to increase private incentives for innovation by granting temporary monopoly power to inventors. In return for exclusivity, the patent owner is required to make the invention public rather than keeping it secret. In principle, then the potential negative consequences for efficiency in the market for products due to the temporary monopoly are counterbalanced by the disclosure of information about the innovation.

Thus in theory the patent system yields several social benefits: providing greater incentives for R&D and diffusion of innovation, reducing the entry barriers faced by innovative startups with limited complementary assets, and increasing the efficiency in the market for intellectual property (Arora *et al*., 2001, 2007). There are corresponding social costs in the form of the transactional and other costs patents may impose on those who wish to build on earlier inventions or combine several together in a new innovation. This problem is particularly important in technological areas characterized by cumulative, sequential innovations (Hall, 2003, among others). Moreover, patents favor an excessive fragmentation of intellectual property and increasing transaction costs due to enforcement and litigation (Heller and Eisenberg, 1998; Ziedonis, 2004). Finally, in industries characterized by strong network externalities and the requirements for standards, patents reinforce the monopoly power of the winners and may reduce future innovation.

The extension of patent coverage to business methods and software in the US system has raised concern that the imbalance between the benefits and costs of the patent system may be unfavorable in this technological area. ‘If it has been a policy experiment, could we determine today that it was successful? Probably not’ (Hunt, 2008: 1). One may ask, however, whether the alleged imbalance between costs and benefits of patents is specific to this particular technology. To help to answer this question with reference to financial patents we have to note some important differences between innovation in financial services and manufacturing.

First, historically legal protection of financial innovations has been particularly weak relative to manufacturing. Trade secret has been the primary legal instrument to protect financial innovations but, unlike software, the use of trade secrets has become more difficult over time because the regulation of the financial sector has required a rising level of product and process transparency (Duffy and Squires, 2008). Moreover, financial institutions are subject to detailed scrutiny by public regulatory agencies and this may distract resources from innovation, especially for younger, small financial firms (Lerner, 2004). The weak appropriability regime and the use of the Internet favor a rapid diffusion and imitation of financial innovations by competitors. This weakens the incentives for innovation especially in sectors like insurance in which innovators bear the costs of developing a new product and obtaining the regulatory approvals but cannot prevent competitors from imitating their innovations very quickly (Hunt, 2008). In general, however, the lack of legal protection has not prevented the introduction of important product innovations (such as a multitude of financial instruments) and process innovations (such as trading platforms and pricing algorithms) in the financial industry, similar to the situation in the software industry prior to 1994/1995 Q7 (Torrisi, 1989). The history of this industry clearly shows that 'the creation of new financial products and processes has been an ongoing part of economies for at least the past four centuries, if not longer.' (Tufano, 1989: 312).

Second, financial services are characterized by network externalities and strong demands for standardization. For instance, for financial exchanges and payment cards both attractiveness and efficiency (cost) depend on the number of users of the service. In other financial services, such as paper checks and automated clearinghouses, network externalities arise from interoperability, which is achieved by standard setting (e.g., standardized message formats). Standardization and compatibility between products typically give rise to strong market power for the owner of the standard. Patents can reinforce network effects and induce the accumulation of large patent portfolios for cross licensing purposes. In turn, this raises entry barriers and may hamper innovative entrants. Many financial innovations also require collaboration among financial institutions, for example, in syndications of innovative securities or standard setting for secure communication and transaction exchanges, implying a need to share access to patented inventions. In financial markets an innovator's success often relies on the existence of different versions of the innovation developed by competitors. These derivative, complementary innovations are important to 'share the risk, increase market depth, liquidity, and price transparQ8 ency' (Kumar and Turnbull, 2008: 2013). By patenting an innovation with a high potential for sequential innovations, a first-mover then can hamper market growth. Patents may hinder competitors from investing in co-specialized assets Q9 because of the hold-up risk (Kumar and Turnbull, 2008). By the same token, financial innovators who bear significant up-front costs to develop co-inventions compatible with an industry standard may be discouraged by the cost of licensing in the necessary patents. In the case of litigation for patent infringement with a patent-holding company, the innovator finds it necessary to settle at a relatively high cost because of their sunk R&D costs and the costs of abandoning a standard that is already established. Litigation risk can therefore reduce investment in new standards (Hunt, 2008).

Finally, financial patents, like other business method patents, are often characterized by high uncertainty about enforceability. This is due to a number of factors. First is the absence of good non-patent prior art databases. Prior to the State Street v. Signature Financial decision in 1998 business method patent applications were very rare at the USPTO, so that there was little prior art on financial methods in the patent databases. In addition, most business method inventions have a practical nature and can be realized without much written documentation or are simply a known and used process transferred to the Internet (Hunt, 2001; Wagner, 2008). Another reason for uncertainty arises from the use of ambiguous claims in patent applications, which make it difficult to determine the boundaries of property rights for business methods and financial innovations. The importance of this problem for business method patents in general is emphasized by the fact that appeals over claims definition in this area are over six times more likely to occur compared with patents in general (Bessen and Meurer, 2008). Uncertainty over patent validity reduces the incentives to invest in innovation for both the patent holder and for the developers of competing inventions. These effects are strengthened in the presence of cumulative innovation like that in software and financial services. The inventors of subsequent, cumulative inventions may be discouraged by previous inventions that are covered by patents of uncertain validity – because they are obvious or have an indeterminate breadth.

This theoretical and empirical literature overall does not provide clear-cut evidence about the quality and economic importance of financial patents. However, various scholars have raised concerns about the lowering of barriers to business method and financial patents in the US institutional context. We wonder whether the evolution of the US patent system has produced any substantial effects on the application and granting of financial patents at the EPO, although the differences between the two systems remain significant. More precisely, our critical review of the literature on financial patents leads to a set of testable hypotheses that we present below.

The literature suggests that, compared with other patents, financial patents are characterized by a higher level of uncertainty arising from the difficulty of establishing the novelty of financial inventions relative to prior art and the ambiguity of their claims. This uncertainty should affect both the application process and the post-grant litigation. An additional source of uncertainty for financial patent applications filed at the EPO arises from Article 52 of the EPC, which excludes business methods and software 'as such' from patentable subject matters. Examination of financial patents at the EPO then is likely to be particularly complex since examiners have to distinguish pure business methods, which are not patentable, from patentable financial inventions. We expect then the likelihood that we observe a larger grant lag or a rejection is larger for a financial patent than for another patent with identical quality or value characteristics, such as the number of citations received by other patents. These considerations lead to the following two hypotheses:

> **Hypothesis 1a:** *Ceteris paribus*, financial patent applications should have longer decision lags than patent applications in other technological areas.

> **Hypothesis 1b:** *Ceteris paribus*, financial patent applications should have a lower probability of grant than patent applications in other technological areas.

The literature also suggests that the extension of patent coverage to subject matter in which patents are difficult to define and to enforce gives rise to large litigation costs. Previous empirical evidence based on US patents suggests that financial patents, like other business method patents, are a case in point (Lerner, 2006). As mentioned before, the opposition system at the EPO is an important instrument for first-instance challenges to the validity of granted patents. As Harhoff and Reitzig (2004) have noted, this instrument offers a 'fast and inexpensive resolution of legal disputes' (p. 445).[3] Working on patents data in biotech and pharmaceuticals, Harhoff and Reitzig have found that opposition rates are particularly high in new technical areas, such as special areas of biotechnology (p. 457). Their results are in line with the predictions of the theory of legal disputes and settlement (see Cooter and Rubinfeld, 1989 for a survey). Looking at the oppositions filed to the EPO we ask whether the probability that a financial patent is opposed is larger than the probability for non-financial patents of similar quality or value. The uncertainty and claim ambiguity that characterize business method patents in general and the limitations to patentability of business methods 'as such' in Europe suggest that financial patents that have been granted should be litigated more often than other patents. More precisely, we test the following hypothesis:

> **Hypothesis 2:** *Ceteris paribus*, the probability that a financial patent is opposed is greater than that for patents in other technological areas.

Thus far we have focused on the differences between financial patents and other patents, controlling for the quality or importance of patents. One may also ask, however, whether and how quality affects the examination outcome and the post-grant opposition probability in the case of financial patents.

Various studies have demonstrated that the outcome of the examination process (grant, refusal to issue, or withdrawal by the applicant) is only an imperfect measure of the quality or economic importance of a patent (e.g., Lanjouw and Schankerman, 2004b; Hall *et al*., 2005). And, as discussed before, several scholars have cast doubt on the quality of financial patents granted by the USPTO.[4] To better understand financial patenting at the EPO we need to look at more precise indicators of quality and importance of patents. Earlier studies have proposed several measures such as the number of inventors, the number of backward and forward citations, the number of claims and family size, or the number of patent systems worldwide where patent protection is sought for the same invention. The empirical evidence shows that all these indicators, to various degrees, are associated with the importance or economic value of patents (e.g., Lerner, 1994; Harhoff *et al*., 1999; Hall *et al*., 2005). Other studies have also found that a linear combination of these indicators can serve as a proxy for the economic value of patents (Lanjouw and Schankerman, 2004b; Hall *et al*., 2007; Gambardella *et al*., 2008).

Finding measures of patent 'quality' is somewhat more difficult. For example, references to prior patent art (backward citations) can be a somewhat ambiguous such measure. Some scholars have suggested that large numbers of citations to others reveal that a particular invention is likely to be more derivative in nature and, therefore, of limited importance (Lanjouw and Schankerman, 2004a). However, a large number of backward citations may also indicate a novel combination of existing ideas. This is probably the reason why Harhoff *et al*. (1999) have found that backward citations are positively correlated with patent value. A more precise indicator is provided by the number of X-type and Y-type citations that are references to prior art potentially challenging the novelty claims of the patent.[5]

The lack of documented prior art and the uncertainty surrounding financial patents may make it difficult for EPO examiners to identify patents that provide a significant, non-obvious contribution to prior art. This suggests the possibility that financial patents that are of low quality (lack novelty or are obvious) may be granted. Such patents are also likely to be of low value, social or economic. We expect that, despite the difficulties mentioned before, the traditional severity of the EPO examination system (see, e.g., Quillen *et al*., 2002) and the EPC restrictions on business method patentability help patent examiners to distinguish important patents (e.g., patents that will receive many citations) from patents that provide a modest contribution to prior art (e.g., the patent cites prior art potentially challenging its novelty claims).[6] Moreover, we expect that the number of claims, a proxy for patent complexity (Harhoff and Reitzig, 2004), will slow the patent office decision and reduce the likelihood of grant. These considerations lead to the following hypothesis:

> **Hypothesis 3:** *Ceteris paribus*, financial patents are less likely to be granted if they have fewer citations received, contain a large number of claims, or have several overlapping claims with earlier patents (many XY-type backward citations).

Our final hypothesis concerns the probability that a financial patent will be challenged by an opposer after it is issued. The theory of legal disputes suggests that patent oppositions are likely to occur under conditions of high uncertainty and imperfect information. This is one reason why we expect that the complexity and problematic enforceability of financial patents relative to other patents make them more likely to be opposed.[7] However, the theory of legal disputes and their resolutions also argues that valuable patents will be litigated more frequently because there is more at stake (Cooter and Rubinfeld, 1989 for a survey).

Empirical studies on US patents (Lanjouw and Schankerman, 2001, 2004a, b), US financial patents (Lerner, 2006), and EPO patents in biotech and pharmaceuticals (Harhoff and Reitzig, 2004) have found evidence on the association between the value of patents and litigation. All of these studies found that citations received (a proxy for value) are positively associated with litigation. However the findings using backward citations (a proxy for the quality of disclosure or for the crowdedness of the technological space) vary considerably. Lanjouw and Schankerman (2004a) find that backward citations per claim are negatively associated with litigation probability, whereas Lanjouw and Schankerman (2004b) find that other value measures are positively correlated with litigation. However, Lerner (2006) found that backward citations in financial patents are positively associated with litigation. Harhoff and Reitzig (2004) provide a potential resolution of this conundrum using EPO patents, in which it is possible to distinguish among the types of citations made. They found that it is the citations to patent literature that potentially challenge the novelty claims of the patent (X-type citations) and not the other backward citations, which predict opposition. This finding suggests that more incremental (less valuable) patents or patents with a technologically close competitor are more likely to be opposed.

The probability of litigation in the US has also been found to increase with the number of claims both for all patents (Lanjouw and Schankerman, 2004a) and for financial patents (Lerner, 2006). The economic interpretation of claims is quite controversial. It is unclear whether they are a measure of patent complexity (Harhoff and Reitzig, 2004) or a proxy for potential profitability (Lanjouw and Schankerman, 2004b) or, most likely, a combination of both. In any case, we expect the number of claims to be related to opposition.

Finally, the potential economic value of an invention will determine the applicant's willingness to file for a patent in multiple jurisdictions because doing so involves substantial expenditure (not just the patent office fees, but also the costs of attorneys, translation fees, etc.). For this reason, and beginning with the work of Putnam (1996), the number of patent applications that share the same priority date as the patent in question (the family size) is a frequently used proxy for patent value (Harhoff *et al.*, 2003; Harhoff and Reitzig, 2004).

These considerations lead to the following two hypotheses:

Hypothesis 4a: *Ceteris paribus*, more valuable financial patents (i.e., those with more forward citations or a larger family size) are more likely to be opposed.

Hypothesis 4b: *Ceteris paribus*, more controversial financial patents (those with more claims or more XY-type backward citations) are more likely to be opposed.

The above concludes the presentation of our hypotheses. In order to test them, we need to identify financial patent applications at the EPO, and a corresponding sample of non-financial patents for comparison. This task is described in the next section of the paper.

Data

Defining financial patents

Q10 As in the case of software or business method patents (Hall, 2003; Hall and MacGarvie, 2006; Hall *et al.*, 2007; Bakels *et al.*, 2008), identifying financial patents precisely (with no Type I or II error) is difficult. To some extent, the difficulty lies in the fact that we do not have a precise definition of what we mean by a financial patent, although we are fairly sure we can tell one when we see it. The most important IPCs in which the patents we identify as financial may be found are described as 'complete banking systems,' 'mechanisms activated by other than coins … to actuate vending, etc. … by credit card,' 'office automation or reservations,' 'finance, e.g., banking, etc.,' 'payment schemes,' and also by more generic terms such as 'Digital computing or data processing equipment.' Many, but not all, of these patents are associated with payment systems, cash machines, or vending machines, but some are more related to innovation in financial instruments. We found it essential to use keywords to restrict any set of patents identified simply using technology classes.

Duffy and Squires (2008) have examined a sample of recently granted USPTO patents classified in the USPC class 705/35.[8] They found that only a few of these patents are about sophisticated trading mechanisms, valuation metrics, or innovative financial products. The innovations described are all relevant to the financial industry but they are not pure financial innovations. Moreover, among the patents closely connected with finance, only a few disclosed 'cutting edge financial engineering … cognizable as a significant development in financial theory' (Duffy and Squires, 2008: 26). Their evidence suggests that it may be important to develop robust definitions to identify financial patents in the US and EPO. We begin such an exploration here, but are also aware that there is room for further work in this area.

Our investigation explores three different methods of choosing such patents: (A) EPO equivalents of USPTO patents in certain finance-related class/subclass combinations;[9] (B) EPO patents in a set of IPC/ECLA finance-related classifications; and (C) EPO patents in technology classes where 'pure play' financial firms patent. Financial patents at the EPO seem to be scattered among a large number of classes and there was relatively little overlap across the three sets. Therefore we used the union of the three sets as our definition, but at the same time we restricted the sample to those with one of eight specific keywords in the title or abstract: *transaction, financial, credit, payment, money, debit card, portfolio*, and *wallet*. After dropping a few observations due to missing applicant information, this yielded a sample of 3298 patents with priority year between 1978 and 2005, about 4% of the initial 87,719 patents in the union of sets A, B, and C.

The analysis in the next section of the paper is based on a comparison of financial patents with all other patents. To form the comparison group of all patents we took a random 1% sample of the EPO database (excluding financial patents), obtaining 18,523 patents. The relatively large size of the sample ensured that the sampling variability of the comparison group was rather small.

Variable definitions

Table 1 illustrates all the variables used in the analysis. Dependent variables refer to the outcome of the examination process: refusal of the application, withdrawal of the application, or a patent grant. Independent variables are classified into three categories: variables describing the prior art base of the patent, variables related to patent value or importance, and variables describing the patent owner.

Trends and descriptive statistics

The trends of aggregate and financial methods patenting at the USPTO and EPO are displayed in Figures 1 and 2, respectively. Figure 1 shows aggregate EPO grants and applications and USPTO patent grants (all by priority year), while Figure 2 shows the trends in financial methods patenting at the two agencies.[10] Note that prior to about 1991 or 1992 the trends in all patents and financial patents

Table 1 Description of variables employed in the analysis

Variable	*Description*
Dependent variables	
Decision reached	A dummy variable that takes the value 1 if the patent application has been granted, rejected, or withdrawn. Knowing whether a decision has been reached for a patent application provides useful information about the complexity and uncertainty of the examination process.
Grant	A dummy variable that takes the value 1 if a patent has been granted at the EPO.
Grant lag in years	Number of years between the priority date and the grant date.
Refusal	A dummy variable that takes the value 1 if a patent has been rejected for grant at the EPO.
Withdrawn	A dummy variable that takes the value 1 if a patent has been withdrawn by the applicant before grant at the EPO.
Opposition	A dummy variable that takes the value 1 if a patent has been opposed at the EPO. Oppositions can be filed at the EPO within 9 months from the granting date.
Independent variables describing the prior art base	
Inventors	Number of inventors in a patent.
Non-patent literature references	Number of cites to the non-patent literature in the patent document, which has been shown to be related to the closeness to 'science' and patent value (e.g., Meyer, 1999).
Backward citations to patents	Number of cites to other patents in the patent document. A higher number of citations may indicate that the patent relies on a broader knowledge base and hence is more important. However, it may also suggest that the patent is more derivative in its nature or that it is in a crowded technological area and so has narrow breadth.
XY-type backward citations	Number of citations made whose claims overlap completely or partially with at least one claim of the focal patent application. At the EPO the task of the examiner consists not only in the identification of patent documents that can be considered prior art for a given patent application, but also in the classification of the prior art patent(s) by degree of importance to that patent application.
Citation lag in months	Measures the average age of the backward citations in months.
Priority year	Dummy variables based on the priority year of the patent
Independent variables related to patent 'value' or 'importance'	
Patent family size	Number of patents internationally that share the same priority. Economic value is related to the willingness of the patentee to pay the various fees involved in taking out a patent on the same invention in multiple jurisdictions.
Number of designated states	Number of EPC nation-states in which the applicant can request coverage when the patent is issued.
PCT route	A dummy variable that signal whether the applicant has filed an international application to extend patent protection beyond the EPC member states.
Number of technology classes	Number of technology classes (IPCs) in which the patent was classified by the EPO; this is often considered a measure of breadth or scope. The number of technological classes has been shown to be an indicator of technological 'quality' similar to the number of citations by Lerner (1994). However, as noted by Guellec and Pottelsberghe de la Potterie (2000), this variable may be also a measure of ambiguity reflecting the difficulty of the examiner in locating the invention in the technological space.
Forward citations	The number of forward cites received by the patent or its equivalents during the first 3 years (from PATSTAT). This is a measure of the technological importance of the innovation.
Continuation	A dummy variable if the patent had at least one divisional at the EPO that shared the same priority. Because divisionals occur when a patent describes more than one invention, this may also be an indicator of a broader or more valuable patent.
HTT composite index	A composite value index based on family size, forward citations, and the number of IPC classes at the 8-digit level, described in Hall *et al.* (2007). They show that this composite index is associated with firm market value after controlling for several other variables in a sample representing about 1000 largest R&D doers among European publicly listed firms. A similar methodology was first developed by Lanjouw and Schankerman (2004b).
Number of claims	A count variable of the number of claims of the patent at the moment of grant.

Table 1 (*continued*)

Variable	*Description*
Independent variables describing the patent owner	
Stock of EP patents	Log stock of EP patents of the patentee (depreciated at 15% annual rate) – a proxy for the experience of the patentee
Stock of XY backward cites	Log stock XY-type backward citations of the patentee (depreciated at 15% annual rate)
Stock of forward cites per patent	Log stock of forward cites per patent of the patentee. This variable is obtained by dividing EP patent citations received (first 3 years only, depreciated at 15% annual rate) by the stock of patents depreciated at same annual rate – a measure of the average value of the patentee's inventions
Size of the patentee	A categorical variable for firm size. Small: 1–50 employees; medium: 51–250 employees; large: more than 250 employees.
Age of the patentee	Dummies for firms that were founded between 1981 and 1995, and after 1995, with those founded prior to 1981 the left-out category.
Sector of the patentee	Dummies for the six leading sectors plus the remainder in the left-out category.
Country of the patentee	Dummies for the US, Japan, Germany, France, and the UK, with the remaining countries as the left-out category.

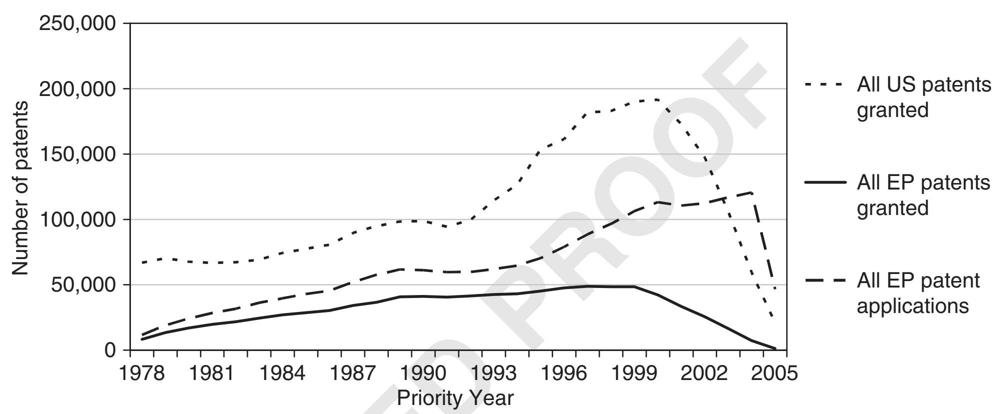

Figure 1 Aggregate patenting trends by priority year at the EPO and USPTO.

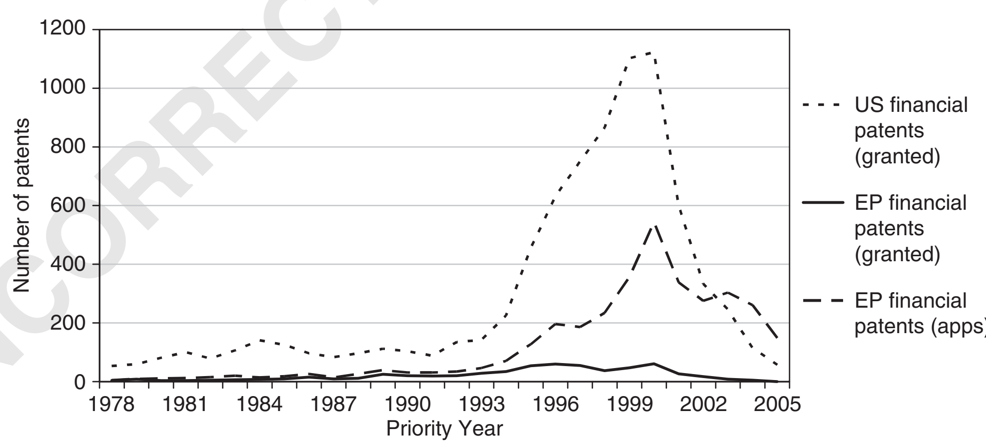

Figure 2 EP and US financial methods patenting.

are very similar. The growth of EP financial patenting follows the growth of US financial patents closely, although the latter set accelerates more rapidly in 1999 and 2000 and decelerates more quickly after that.

Relative to overall patenting activity, financial patents show a very rapid growth in the years 1994 and 1995, which are the years of the main software patentability decisions in the US, and also the years during which the use of the

Internet took off in that country. Both in the EPO and USPTO, by 2006 there were approximately three times as many patents as in 1991 overall, and six times as many financial patents. Even though the EPO subject matter restrictions in the software and business method area are narrower than in the US, the growth of financial patents at the EPO doubtless reflects the impact of the State Street decision in the US in 1998 and the changing attitudes toward patenting among business services and financial firms which that decision engendered.

Note also that at the end of the period (after about 2001), there is a substantial falling off in all types of patents due to the lag between priority year and publication (at the EPO) or grant (at the USPTO). Nevertheless, there also appears to be real decline in the growth rate of patent applications at both offices, which is not accounted for by the grant lag. This trend may be only partially due to a change in the application strategy after the Business Patent Initiative was announced by the USPTO in year 2000. Since the aim of this initiative was to raise the examination standards for patent applications in class 705, applicants may have tried to avoid filing applications in this class by a careful choice of wording. However, this does not explain the decline in the growth rate of total patent applications.

To illustrate the characteristics of the patentees who take out financial patents at the EPO, we focus on the 90% that are taken out by businesses.[11] We look at the country of origin, the business sector, and the size of firm. In our regression analysis we ask how these variables are related to outcomes at the EPO. To save space, we summarize the main characteristics of patentees.

A large share of EP financial patents are filed by US applicants (49% *vs* 34% for European patentees and 13% for Japanese patentees), with the surge from the US beginning some 4–5 years earlier than that from the EU. Prior to 2000, applicants from the US accounted for over half (57%) of the financial patents at the EPO, and after 2000, only 45%. The overall decline in patenting and the shifting shares probably reflects two things: the dotcom bust in 2001, which had a bigger impact in the US, and the diffusion of patenting activity in this area to European firms.

This distribution however remains clearly more asymmetric in favor of US applicants than overall patenting activity or even patenting in Information and Communication Technologies at the EPO (see *Patent Compendium*, Q11 OECD 2008). The persistent large share of US assignees probably reflects the differences in the treatment of financial and business method patents between the US patent system and other systems. Another plausible explanation is the high intensity of financial innovations in the US economy vis-à-vis other economies. For comparison, we also examined the distribution of assignee country for financial patents filed at the USPTO, which is even more skewed toward US. It also shows that most of the patenting at this office is accounted for by applicants in the US, Japan, and the EU. The share of financial patents held by US patentees rose during the 1990s and then fell somewhat after that as European applicants increased their share. About two-thirds of European-owned financial patents come from the three largest countries, the UK, Germany, and France.

Table 2 in the text depicts the distribution of financial patents by the main activity of the patentee. We used different sources to identify the main activity of the applicant, successfully obtaining this information for almost all (99.7%) of the financial patents owned by businesses.[12] There is a very high concentration of patents in a few sectors: in particular, only six sectors account for about 70% of the financial patents overall and 82% from the business sector, with four of them being services – computer services including software, financial services, telecommunications, and other business services – and the remaining computer-related hardware. This is in line with the concentration of software patents reported by Hall *et al*., (2007).

The concentration of patents in these six sectors is higher for US applicants than for EU applicants. Moreover, the two leading sectors in Europe differ significantly from the ones in the US: in the former case telecommunication firms, computer-related services, and communications equipment are responsible for 52% of the business sector financial patents, whereas in the US, firms in the computer hardware, computer services, and financial sectors hold 73% of them. In Europe, firms in the financial sector account for only 11% of business sector financial patents. These differences in distribution doubtless reflect the strength of the telecommunications sector relative to the software and financial sectors in Europe vis-à-vis the US.

Prior to 1994/1995 there was little patenting in this area. After the US CAFC removed the restriction on patentability of software as such in 1995 and then again after the State Street decision in 1998, there were spikes in financial patent applications, the first due to computer hardware, telecommunications, and other business sectors, and the second mostly from computer hardware and finance and insurance. Between 1993 and 1998 the average annual patenting in this technology jumped from 20 patents per year to 100 patents per year. However, in the period after 2000 the growth appears to have moderated somewhat and a higher share come from software and finance/insurance firms. The breakdown by sector and firm age demonstrates that the service firms that hold financial patents tend to be much younger than the manufacturing firms. Thus even in Europe, there appears to be a shift in attitudes toward patenting among the newer entrants in business service sectors.

The majority of financial patents are obtained by large patentees: however, their role decreased somewhat after 1999 in favor of the small-sized firms. Moreover, the small patentees are concentrated in a few sectors. Indeed, about 78% of the financial patents held by small-sized firms are held by firms in three service sectors – software, financial, and other business services – whereas these sectors account for less than half (40%) of patents filed by large firms. It is interesting to note that SMEs account for about 24% of financial patenting at the EPO.

The small patentees operating in the service sectors are also new firms: firms born after 1995 account for over 60% of the financial patents by small patentees, whereas their role in the overall patenting is minimal. There are a number of newer entrants among the top 100 patentees, such as Bitwallet (electronic money service provider in Japan), Orbis Patents (patent holding company in Ireland),

Table 2 Patent counts by the country and sector of the patentee

Sector Description	*Overall*		*EU 27*		*US*	
	N	*Share*[a] *(%)*	*N*	*Share*[a] *(%)*	*N*	*Share*[a] *(%)*
Office, accounting and computing machinery	624	20.8	45	4.5	378	25.3
Computer services and related activities	570	19.0	212	21.3	323	21.6
Finance and insurance	532	17.7	106	10.7	388	26.0
Post and telecommunications	290	9.7	182	18.3	67	4.5
Other business services	227	7.6	69	6.9	132	8.8
Radio, television and communication equipment	226	7.5	123	12.4	47	3.1
Electrical machinery and apparatus, nec	162	5.4	108	10.9	6	0.4
Medical, precision and optical instruments	91	3.0	44	4.4	23	1.5
Wholesale and retail trade repairs	65	2.2	33	3.3	23	1.5
Machinery and equipment, nec	60	2.0	23	2.3	28	1.9
Chemicals excluding pharmaceuticals	24	0.8	1	0.1	22	1.5
Pulp, paper, paper products, printing and publishing	21	0.7	18	1.8	1	0.1
Health and social work	11	0.4	0	0.0	10	0.7
Motor vehicles, trailers and semi-trailers	10	0.3	3	0.3	2	0.1
Coke, refined petroleum products and nuclear fuel	9	0.3	0	0.0	6	0.4
Air transport	9	0.3	2	0.2	6	0.4
Manufacturing nec recycling (include furniture)	8	0.3	1	0.1	5	0.3
Aircraft and spacecraft	7	0.2	1	0.1	6	0.4
Other community, social and personal services	7	0.2	4	0.4	2	0.1
Food products, beverages, and tobacco	6	0.2	1	0.1	5	0.3
Land transport, transport via pipelines	6	0.2	1	0.1	3	0.2
Research and development	6	0.2	3	0.3	1	0.1
Rubber and plastics products	5	0.2	1	0.1	4	0.3
Construction	4	0.1	2	0.2	1	0.1
Production, collection, and distribution of electricity	3	0.1	2	0.2	1	0.1
Supporting and auxiliary transport activities	3	0.1	1	0.1	2	0.1
Real estate activities	3	0.1	3	0.3	0	0.0
Pharmaceuticals	2	0.1	1	0.1	0	0.0
Fabricated metal products except machinery and equipment	2	0.1	2	0.2	0	0.0
Mining and quarrying (energy)	1	0.0	0	0.0	0	0.0
Mining and quarrying (non-energy)	1	0.0	1	0.1	0	0.0
Iron and steel	1	0.0	0	0.0	0	0.0
Non-ferrous metals	1	0.0	0	0.0	0	0.0
Hotels and restaurants	1	0.0	0	0.0	1	0.1
Top six business sectors	2469	82.4	737	74.2	1335	89.4
Total for all business sectors	2998	85.2	993	80.3	1493	88.4
Individuals and non-business organizations	511	14.5	240	19.4	191	11.3
Patents held by non-classified business firms	11	0.3	4	0.3	5	0.3
Total, including double counting for co-patenting	3520	—	1237	—	1689	—

[a]The share of business sector financial patents is shown in these columns, with the exception of the last three rows in which the share of all financial patents is shown.

Trintech (transaction software provider in Ireland), and Contentguard (DRM technology in the US).

In contrast, the great majority of patents held by large firms are held by firms that were founded prior to 1970, as one might expect. Typically the emergence of smaller firms active in financial patenting is associated with the advent of the so-called Internet economy in the 1990s. Their business models often rely on licensing transactions and financial models embodied in a software application that uses non-exclusive technology contracts. In contrast, a large share of the communication equipment and telecommunications firms that have financial patents were born during the 1981–1990 period with the advent of wireless and cell telephony.

A higher propensity to patent is consistent with the active participation in technology markets, where IP protection of the goods being traded is important. Ongoing research has not yet reached a definitive conclusion on the sustainability in the long run of such business strategy. However, the development of specialized technology providers in the financial area could be considered a quintessential example of the vertical disintegration that takes place when ownership of innovation assets becomes Q12 available (Arora *et al.*, 2007; Thoma, 2009).

Comparing financial patents to other patents

In this section the characteristics of financial patents are compared with all patents at the EPO in order to explore potential differences regarding the prior art base and to get some idea of the economic value or importance of this kind of patenting.

Because most of the variables we consider will vary systematically over time, and because financial patents are disproportionately represented in the later years, we normalized each of the variables by its overall year mean before performing tests for differences between the two samples. Table 3 shows the results of our analysis: it contains some simple statistics on the unadjusted data for the two sets of patents, and the results of *t*-tests comparing financial patents with all other patents. These tests were conducted using the priority year normalized variables. We used a conventional two-sample *t*-test for differences in the mean, allowing the two samples to have different variances.

The upper panel of Table 3 reports some measures of the prior art base for the two sets of patents. Financial patents cite slightly newer prior art than patents as a whole (average age about 60 months *vs* 64 months), and the difference is significant. They also have significantly fewer backward citations (whether XY or otherwise) and citations to the non-patent literature. They have the same number of inventors on average, suggesting that the resources invested in them are roughly comparable with resources invested in other patents.

The middle panel of Table 3 shows some indicators that are commonly associated with patent value: the number of

Table 3 Comparing financial to all other patents

	All patents			*t-test*[a]	*Financial patents*		
	18,523 *observations*[b]			*Financial patents vs all other*	3298 *observations*		
	Mean	*S.d.*	*Median*		*Mean*	*S.d.*	*Median*
Indicators of prior art base							
Inventors	2.44	1.79	2.0		2.53	2.08	2.0
Non-patent literature references	0.49	1.4	0.0	−−	0.46	1.13	0.0
Backward citations to patents	3.75	2.98	3.0	−−−	3.34	3.27	3.0
Backward citations per inventor	2.28	2.32	1.7		2.05	2.45	1.3
XY-type backward citations	0.88	1.6	0.0	−−−	0.87	1.44	0.0
XY-type backward citations per inventor	0.51	1.06	0.0		0.53	1.03	0.0
Citation lag in months[c]	63.6	42.7	52.5	−−−	59.5	37.0	50.0
Indicators of patent value							
Number of claims	14.89	12.77	11	++	21.78	17.78	17
Technological classes	7.16	6.96	6.0	−−−	5.77	4.61	4.0
Patent family size (worldwide equivalents)	11.03	74.05	6.0		11.40	30.54	6.0
Continuations rate	0.05	0.21	0.0		0.05	0.21	0.0
Designated countries	11.95	9.10	9.0		14.50	9.88	18.0
Application via PCT route (dummy)	0.40	0.49	0.0	+++	0.44	0.50	0.0
Forward citations after 3 years	0.41	0.97	0.0	+++	0.67	1.81	0.0
HTT composite index	0.00	0.54	−0.1	+++	0.12	0.65	−0.1
Value from PATVAL survey (1000s euros)[d]	11,083	65,580	650	−−−	1,523	2,791	200
Status							
Decision reached	0.760				0.580		
Granted, conditional on decision	0.640				0.341		
Refused, conditional on decision	0.033				0.071		
Withdrawn, conditional on decision	0.327				0.588		
Grant lag in years[e]	3.91	1.78	3.59		5.10	2.23	4.77
Opposition if granted[e]	0.065			++	0.090		

[a] *t*-test for the hypothesis that the mean for financial patents differs from that for all patents. Significant at 1% (+++), 5% (++), or 10% (+) level if the mean is larger; similarly for smaller but with a minus (−). Before testing, all variables have been normalized by the overall year mean to remove the trends.
[b] This is a 1% sample of all patents.
[c] Computed for non-zero lags only. Numbers of observations are 1077 and 833.
[d] Computed for patents that were covered by the PATVAL survey only. Numbers of observations are 5 and 8281.
[e] Computed for granted patents only. The observations are 9003 and 736; for grant prior to 2001, they are 8883 and 642.
The definitions of all variables are given in Table 1.

claims, the number of technology classes (IPCs) in which the patent is classified, the number of patents in the rest of the world with the same priority date (the number of equivalents), whether there are one or more divisionals (continuation) at the EPO associated with the patent, the number of countries in which coverage was requested at the EPO, the number of citations received by the patent in the first 3 years after grant, and the HTT composite index based on family size, IPC classes, and forward citations.[13]

On a number of these value measures, financial patents differ substantially from other patents. Financial patents have similar equivalents (family size), divisionals, and number of designated states. They have more claims, are more likely to be cited, and are more likely to reach the EPO via the PCT route. The composite value index of family size, citations, and the number of IPCs is higher on average than that for other patents once we adjust for differences across priority years. Note that the higher rate at which financial patents are cited may indicate higher social value as well as higher private value because it implies greater 'spillovers' of knowledge to future inventors than yielded by the typical patent. We should notice that small population of financial patents at the EPO reduces the likelihood of citations between financial patents. The high number of citations received then suggests that these patents are mostly cited by patents from different technological classes. The larger number of citations received by financial patents is in line with the large number of forward citations of business method patents reported by Wagner (2008).

Financial patents are classified into significantly fewer IPC classes than all patents, which is a bit surprising, since business methods and software inventions are excluded from the patentability 'as such' in EPO according to Article 52 of the statute, and hence there is a lack in EPO of a clear technological classification for this type of patenting; nevertheless, this fact seems to lead the examiner to place the patent in fewer, rather than more, classes. The suggestion is that these patents have less breadth of applicability.

Finally, financial patents have a significantly larger number of claims compared with other patents, which suggests a greater complexity as compared to other patents.

Outcomes at the EPO

Most of the analysis in this paper is based on the published patent documents on the EPO website. These documents are patent applications that may ultimately be rejected, withdrawn, or granted by the EPO. One indicator of the 'quality' or eligibility of these financial inventions for patenting is their experience in the EPO examining and granting process (Harhoff and Wagner, 2005). In the bottom panel of Table 3, we show some simple statistics on this question for our two groups of patents. The first question is whether a decision has yet been rendered by the EPO. For three quarters of all patents, the answer is yes, but for financial patents there are somewhat fewer decisions, partly because their applications are on average newer. When we adjust for this fact, these applications are just as likely to have received a decision.

The possible outcomes for an application are that it is granted, that the EPO refuses it, or that the applicant withdraws it after negotiation with the EPO. The decision to withdraw a patent application can be considered equivalent to having received a rejection. In this way, the patentee can preempt a potential rejection decision of the examiner after the dispatch of the results of the examination process (Lazaridis and van Pottelsberghe, 2007).

Table 3 shows clearly that conditional on a decision having been reached, financial patents are far less likely to be granted than other patents, indicating that the EPO is finding these applications unpatentable more often than other patents, which is probably related to the subject matter restriction of Article 52. Correspondingly, they are more likely to be either refused or withdrawn. If they are granted, the process takes longer than other patents (as suggested earlier). Once again, after adjusting for the differences in time profiles, these differences are not statistically significant. Note that granting rates for business methods patents overall are significantly larger than for overall patents (Wagner, 2008).

The final step in the EPO process before the patent becomes a set of national patent rights that can be enforced in national courts is the 9-month post-grant window during which any third party may file an opposition against the patent showing that it should not have been granted. The overall rate at the EPO for opposition during the 1978–2005 period is about 6.5%, but financial patents have been opposed 9% of the time, which is significantly higher.

The aggregate numbers mask some interesting changes that have occurred over time. In Figures 3 and 4 we show the evolution of the grant rates and opposition rates,

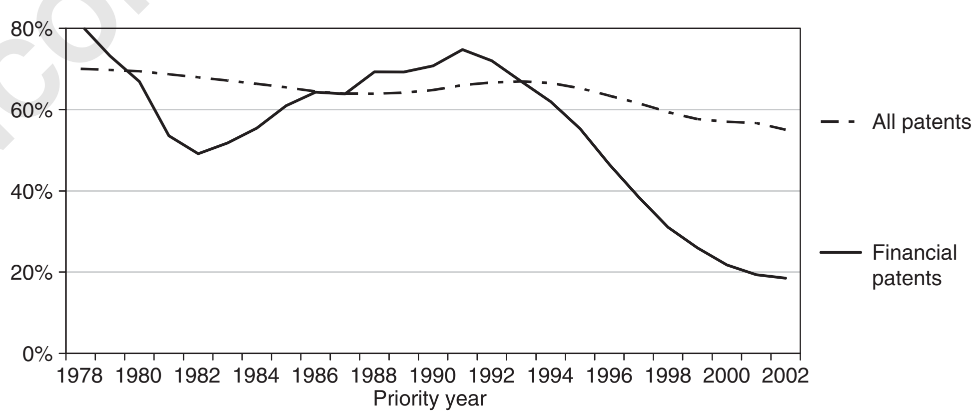

Figure 3 Grant rate at the EPO, conditional on a decision (5 year moving average).

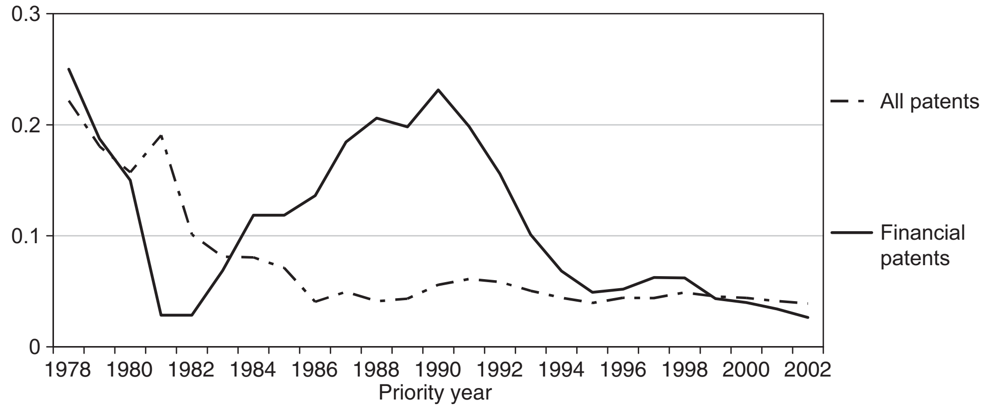

Figure 4 Opposition rates at the EPO, conditional on grant (5 year moving average).

respectively, for the two groups of patents at the EPO between 1978 and 2002.[14] Three periods can be discerned: In the first, roughly 1978–1985, financial patents were not only much less likely to be granted than the other patents, but also less likely to face opposition, once granted. Between 1986 and 1993, grant rates for all types of patents were roughly comparable, while financial patents were about three times as likely to be opposed once granted. Then beginning around 1994, the grant rate for financial patents fell precipitously along with the opposition rates. Financial patents now face the same rate of opposition as other patents. The conclusion is that greater scrutiny at the EPO has led to a decrease in the issuance of controversial patents; the question remains whether this has also eliminated more valuable patents.

The determinants of EPO outcomes for financial patents

In order to test Hypotheses 1 and 2 and to explore the determinants of a successful application at the EPO, we estimated a series of probit equations for the probability of a decision conditional on an application, a grant conditional on a decision, and opposition conditional on a grant. Controlling for average differences across time, whether a decision has yet been reached can be an indicator of the quality of the original application and of the speed with which the patentee pursues the application. Given a decision, whether or not the patent is granted is first and foremost an indicator of invention quality, and also of whether the invention is viewed as satisfying the subject matter restrictions. Finally, opposition has been shown repeatedly to be an indicator of the economic value and importance of the patented invention (Harhoff *et al.*, 2003, Harhoff and Reitzig, 2004).

The explanatory variables for these equations are a selection from the variables described previously, plus a dummy for financial patents. That is, in order to test Hypotheses 1a, 1b, and 2, we ask whether financial patents are more or less likely to receive a decision, be granted, and be opposed given their prior art and value characteristics and priority year. All variables except the continuation (divisional) and PCT dummies are in logarithms to facilitate interpretation. We also included a complete set of priority year dummies in the regressions.

The results are shown in Table 4. As expected, the sample sizes get successively smaller from decision conditional on application, grant conditional on decision, and opposition conditional on grant. In the latter case we removed a few observations for 2004 and 2005, since there were too few grants corresponding to those priority years for opposition to be observed. The three groups of variables (priority year dummies, prior art indicators, and value indicators) were always highly jointly significant using a Wald-type test. In general, the results for these variables agree with those in prior work: backward references increase the probability of receiving a timely decision, but not if they are of the XY-type, whereas backward references to patents increase the probability of a grant, with XY-type backward citations reducing the probability substantially and increasing the probability of opposition, once the patent is granted.

Almost all the value indicators reduce the probability of receiving a decision and of having that decision to grant the patent, while increasing the probability of opposition significantly, as expected. The one important exception is the size of the patent family: this has no impact on the speed with which a decision is reached, but a substantial impact on the probability of a grant (an increase of 0.37 from a doubling of the family size). This may reflect the fact that the inventions associated with patents that have been applied for in many jurisdictions are more important (have greater novelty) and are more likely to have satisfied the subject matter restrictions.[15]

Financial patents are strikingly different from other patents with the same characteristics, being less likely to receive a decision, less likely to be granted, and slightly more likely to be opposed. Thus Hypotheses 1a and 1b, which state that financial patents will have longer decision lags and are less likely to be granted, fail to be rejected. The evidence in favor of Hypothesis 2 that financial patents are more likely to be opposed, c. p., is somewhat weaker, but that may be due to the relatively small sample of oppositions (53 for the financial patents).

All of this suggests that these patents are of lower quality technologically than the others and simultaneously more valuable or at least more controversial, other things equal. Because of the higher opposition rate faced by financial patents, which concords with the value indicators shown in Table 3, we can conclude that these patents, once granted, are expected to be of higher economic value than other

Table 4 Probability of decision, grant, and opposition conditional on grant 1978–2005 Financial patents *vs.* a 1% sample of other patents

Dependent variable	*Examiner's decision*		*Grant conditional on decision*		*Opposition conditional on grant by 2003*	
	Marginal effect	*s.e.*	*Marginal effect*	*s.e.*	*Marginal effect*	*s.e.*
D (financial patent)	−0.054	0.008***	−0.240	0.014***	0.018	0.011*
Inventors (log)	−0.050	0.006***	0.017	0.011*	0.001	0.006
Non-patent literature references (log)	0.013	0.006**	−0.042	0.009***	−0.016	0.006***
Backward citations to patents (log)	0.064	0.005***	0.077	0.009***	0.005	0.005
XY-type backward citations (log)	−0.015	0.005***	−0.104	0.008***	0.016	0.005***
Claims (log)	−0.055	0.005***	−0.091	0.007***	0.007	0.004
Technological classes (log)	−0.010	0.005**	−0.083	0.008***	−0.010	0.004**
Family size (log)	0.006	0.005	0.369	0.016***	0.020	0.005***
D (continuation)	−0.181	0.020***	−0.085	0.026***	0.021	0.012**
Designated countries (log)	−0.033	0.003***	−0.017	0.006***	0.026	0.005***
D (PCT route)	−0.086	0.006***	−0.143	0.011***	−0.018	0.006***
Forward citations after 3 years (log)	−0.014	0.007**	0.051	0.009***	0.026	0.005***
Number of observations (number = 1)	23,011 (16,689)		16,689 (10,034)		9779 (705)	
Pseudo R^2	0.454		0.173		0.051	

Marginal effects and their robust standard errors are shown. Significance at ***1%, **5%, *10%. All equations include a complete set of priority year dummies.
The definitions of all variables are given in Table 1.

patents. As we argued earlier, the outcomes of financial patents relative to other patents reflect a more stringent scrutiny of this category of patent applications by the EPO. The longer decision lag, however, may also depend on the complexity and uncertainty surrounding these patents compared to others. Finally, the lack of documented prior art may contribute to the difficulty of obtaining a patent grant for financial innovations.

Hypotheses 3 and 4 concern the variation across financial patents and we test these hypotheses in Table 5, in which we repeat the analysis of Table 4 but restrict it to the 90% of the financial patents that are held by firms in order to include the influence of firm characteristics on outcomes at the EPO. The sample consists of 2998 patent applications corresponding to 1021 patentees that have priority year 2005 or earlier. Almost three quarters of the patentees (998 observations) have applied for only one financial patent at the EPO, while one (IBM) has applied for more than 100.

There are two sets of explanatory variables included in these equations: the characteristics of the applicant firm, and the characteristics of the patent application itself. We also include a reduced set of priority year dummies. Three probit regressions are shown: (1) predicting the 1718 decisions for the 2998 applications that have priority year 2005 and a decision prior to October 2008; (2) predicting the 618 grants that emerge from those decisions; and (3) predicting the 53 oppositions filed against the 553 grants that have priority year 2000 or earlier.[16] All standard errors in Table 5 have been clustered by the patent owner, although this makes relatively little difference to their estimates.[17]

Turning first to the probability of obtaining a decision on patentability at the EPO, controlling for patent characteristics and priority year the most important predictor among the owner characteristics are whether the firm is Japanese, which appears to delay the decision considerably; this may reflect delays associated with distance and translation. German firms seem to experience a correspondingly faster decision process. With the exception of medium-size firms that receive a somewhat quicker decision, the firm's size, sector, and past patenting history do not seem to matter much. The stock of patents and XY backward citations have a quite limited impact on the likelihood of obtaining a decision. What do matter are the characteristics of the patent itself: forward and backward cites raise the probability of a decision, while inventors and the number of designated states lower it.[18] This suggests that more valuable financial patents that have more resources behind them take longer to be issued or to be rejected, other things equal. This may reflect the applicant's willingness to extend the process at the EPO when more is at stake.

Once a decision has been reached, however, the probability of grant is more affected by the characteristics of the patent owner. Although size of firm does not matter in the presence of the size of the firm's patent portfolio, sector and country do matter. Patenting experience counts for a great deal: a doubling of the firm's patent portfolio is associated with a 16% increment in the probability that a financial patent is granted. Firms in computing hardware or software experience a higher probability of receiving a financial patent grant than firms in other business sectors, while firms in finance and insurance have a lower probability. This may reflect inexperience on the part of these firms, also when compared with software firms, but it

Table 5 Probability of decision, grant, and opposition conditional on grant 1978–2005

Dependent variable	*Decision*		*Grant conditional on decision*		*Opposition conditional on grant*	
	Marginal effects	*s.e.*	*Marginal effects*	*s.e.*	*Marginal effects*	*s.e.*
Owner characteristics						
Log (stock of EP patents)[a]	−0.079	0.045*	0.157	0.059***	−0.036	0.032
Log (stock of XY backward cites)[a]	0.059	0.031*	−0.051	0.034	−0.001	0.014
Log (stock of forward cites per patent)[a]	−0.030	0.046	0.108	0.077	−0.029	0.038
D (small firm)	0.047	0.045	−0.048	0.064	0.040	0.055
D (medium firm)	0.108	0.042**	0.003	0.073	0.072	0.071
Founded 1981–1995	0.039	0.039	−0.031	0.054	−0.022	0.020
Founded after 1995	0.014	0.049	0.042	0.074	−0.051	0.017**
Software sector	−0.053	0.044	0.095	0.058*	−0.012	0.026
Other business services	−0.009	0.051	0.026	0.072	−0.032	0.020
Post and telecommunications	−0.002	0.056	0.086	0.076	0.011	0.027
Finance and insurance	0.070	0.049	−0.119	0.060*	0.016	0.041
Computing equipment	−0.034	0.067	0.254	0.064***	0.029	0.036
Communication equipment	−0.075	0.075	0.093	0.066	0.032	0.050
US owner	−0.040	0.037	−0.130	0.066**	−0.022	0.027
Japanese owner	−0.161	0.060***	−0.128	0.066*	−0.008	0.031
German owner	0.105	0.049*	0.076	0.084	0.110	0.074**
French owner	0.085	0.053	0.081	0.094	0.041	0.048
UK owner	−0.005	0.061	0.027	0.097	0.014	0.052
Chi-squared (2) size	5.5	0.065*	0.9	0.637	1.9	0.389
Chi-squared (2) founding year	1.1	0.593	1.1	0.567	5.2	0.076*
Chi-squared (6) sector dummies	8.5	0.209	25.1	0.000***	3.1	0.800
Chi-squared (5) region	21.0	0.001***	18.2	0.003***	9.2	0.103
Chi-squared (18) firm characteristics	49.9	0.000***	123.3	0.000***	31.0	0.029**
Patent characteristics						
Log (inventors)	−0.053	0.017***	0.015	0.024	0.005	0.015
Log (total backward cites)	0.093	0.018***	0.120	0.023***	0.005	0.020
Log (XY backward cites)	−0.025	0.021	−0.089	0.025***	0.021	0.016**
Log (claims)	−0.041	0.017**	−0.095	0.024***	0.021	0.013*
Log (family size)	−0.041	0.026	0.239	0.031***	0.045	0.014***
Log (*N* of designated states at EPO)	−0.093	0.015***	0.027	0.021	−0.009	0.018
D (PCT route)	−0.114	0.033***	−0.069	0.038*	−0.044	0.016**
Log (forward cites received in 3 years)	0.042	0.019**	0.046	0.021**	0.041	0.012***
Priority year 1986–1990	*combined with pre-1986*		0.103	0.103	0.034	0.049
Priority year 1991–1995	−0.857	0.013***	0.011	0.079	−0.044	0.028
Priority year 1996–2000	−0.995	0.002***	−0.213	0.078***	−0.056	0.037
Priority year post-2000	−0.999	0.000***	−0.231	0.061***	*no oppositions*	
Pseudo R^2	0.302		0.307		0.243	

[a]Stocks for all the firm's patents as of the priority year of the current patent constructed using a 15% depreciation rate.
Financial patents only, 2998 observations for 1021 patentees (1718 decisions, 618 grants, 53 oppositions out of 553 pre-2001 grants)
The left out category is a patent owned by a large firm in the rest of the world that was founded before 1981, and that operates in one of the remaining business sectors, with priority year prior to 1986 (prior to 1991 in the first set of columns).
Marginal effects and their standard errors clustered on patentee are shown. Significance at ***1%, **5%, *10%.
Q13 # All patent characteristics excluding the priority year dummies, which control for selection over time.
The definitions of all variables are given in Table 1.

is more likely to be due to the nature of their patent applications, which may fail the subject matter test more often. Patent application in the hardware sectors are more likely to be for the kinds of software–hardware combinations that are viewed as patentable subject matter by the EPO.[19] US and Japanese patent owners (who presumably are more likely to have patent applications outside the Article 52 restrictions but acceptable to the USPTO) are somewhat less likely to receive a grant of their financial patent application, although the result is not very significant.

Looking at the patent characteristics themselves, our Hypothesis 3 stated that financial patents with few forward citations, many overlapping claims with earlier patents, and a large number of claims are less likely to be granted. All of this finds confirmation in the regression, and we fail to reject the hypothesis. In addition, both designating more states at the EPO and being a member of a large patent family increase the likelihood of a grant once a decision has been reached, even though both delay the decision. Again, this is consistent with greater effort by the patentee when more is at stake.

The final column reports on the predictors of opposition conditional on grant. Unfortunately, the sample size is fairly small and the results, therefore, somewhat weaker than some of those in the literature. It is noteworthy that patent owner characteristics do not predict the probability that a particular patent is opposed, with the exception of very young firms, which are less likely to be opposed, and German firms, which are more likely to be opposed. The main predictors of opposition are the number of forward cites received by the patent, and the family size, both of which are known to be significantly correlated with value, and the number of backward XY cites, which suggests that the opposition occurs because there is some controversy over the extent of the inventive step above a competitor's patent. An additional X or Y cite adds 2% to the probability that a patent will be opposed, which is a large effect given the average opposition probability of 9% for financial patents.[20] The positive sign on claims adds further evidence in favor of the view that more complex, controversial patents are more likely to be opposed.

Hypothesis 4a stated that more valuable patents were more likely to be opposed: these results provide strong evidence that fails to reject this hypothesis. Hypothesis 4b, that more controversial patents are more likely to be opposed, is more weakly supported, possibly because our indicators (claims and XY backward cites) are somewhat weaker proxies for the underlying concept.

A better understanding of the relationship between value or importance, complexity or uncertain enforceability, and opposition would require a more qualitative, in-depth analysis, which goes beyond the scope of this paper. A casual inspection of our data, however, provides interesting insights about the opposition patterns. We found 106 oppositions to 53 financial patents that had a publication date 2000 or earlier.[21] The analysis of opponents and defendants shows that a large share of oppositions has occurred within the financial and insurance sector. Financial patents owned by financial firms receive the largest number of oppositions (33), followed by patents owned by computer hardware and software firms (29). Over half the oppositions (65) come from German firms, which is similar to what was found by Harhoff and Hall (2005) for the cosmetics sector.

Most of the opposers come from the same sectors as the active patentees (computing hardware and software, finance and insurance, and post and telecommunications). By far the most active opposer is Giesecke & Devrient, a German supplier of banknote paper, banknote printing, currency automation systems, as well as smart cards and complex system solutions in the fields of telecommunications, electronic payment, health care, identification, transportation and IT security (PKI). This firm alone filed 21 oppositions to financial patents granted by the EPO, mostly during the first half of the 1990s. Recently, both Swisscom AG and Siemens have been active opposers. These data suggest that opposition involves mostly firms that contribute to financial innovation in various ways – from the development of new financial products and platforms to the creation of the equipment and telecom infrastructure that is needed to implement financial innovations. It is possible that they feel threatened by patents on technologies related to standards in this area; more detailed analysis awaits future work. Q14

Conclusions

This paper presented a first look at the financial patents in the EPO. It began by proposing a definition of such patents, drawing on earlier work using USPTO data. Although in the EPO system software 'as such' and business methods are excluded from the patentable subject matter, we found a substantial number of such patents in the European system. In principle, in order to be patentable at the EPO, these inventions should yield some technical effects and some financial inventions like payment technologies indeed have links with electronic (hardware) devices, such as wireless systems. However, it has often proved to be difficult to establish a clear border between patentable inventions and 'pure' business methods.

Our investigation shows that financial patents are different from other patents in that they rely less on prior literature (patent or non-patent), and the literature they do rely on is younger, which is reasonable given their newness in the patent system. They also are slower to receive a decision at the EPO, which can reflect both the uncertainty surrounding a new and possibly unpatentable subject matter as well as the applicant behavior – that is, its willingness to delay the disclosure of a valuable invention. Once a decision is reached, it is less likely to be a grant, and more likely to be opposed if it is. All this may reflect greater economic value, and we do find that financial patents have several indicators of higher value than other patents. The higher opposition rate may also be due to higher uncertainty surrounding these subject matters, especially in Europe.

Then we have explored the characteristics of financial patentees. First, firms from a few sectors (computers, telecommunication equipment, finance and insurance, and software) account for the bulk of financial patents. Second, large established firms maintain a large, albeit declining share of these patents while small, young firms have a smaller, but rising share of these patents. Small firms include some specialized technology firms whose business model is largely based on technology licensing. Nonetheless, to a great extent these patents are held by the same large firms (IBM, Siemens, Hitachi, etc.) that hold the bulk of software patents at the EPO (Hall *et al.*, 2007).

Finally, we have analyzed how the main characteristics of the patentee and the invention impact on the outcome of the examiner's decision and probability of receiving an opposition. First we find that the probability of grant for financial patent applications – rather than reject (by the EPO) or withdrawal (by the applicant) – is influenced by the owner's stock of EPO patents, country of origin, and whether the applicant is in the computing sector (as opposed to the financial sector). This latter finding could reflect the relative lack of experience with patenting among financial firms. As expected, financial patent applications with more claims (a measure of complexity), or more XY-type backward cites (an indicator of limited inventive step) are less likely to be granted, whereas patent applications with a large number of equivalents in other jurisdictions (a measure of value) are far more likely to be granted.

The analysis of patent oppositions shows that patent-level characteristics including family size, forward citations, and XY-type backward citations have a significant predictive power, but that the characteristics of the patent owner hardly matter. Our conclusion was the unsurprising one, that more valuable financial patents were clearly more likely to be opposed. In addition, there was weaker evidence that more controversial financial patents were more likely to be opposed. Moreover, oppositions mostly involve, as opponents or as defendants, firms that are also important contributors to financial innovations and the underlying IT infrastructure. This result points to an important difference with the US system, in which the most active plaintiffs in patent litigation are patent holder firms specializing in licensing and patent litigation (Lerner, 2006).

Our findings overall offer intellectual property managers and senior managers useful insights into financial innovations and patenting. Our analysis tells the type of financial patent applications that are more likely to affect the decision lag and the probability of a rejection at the EPO. They also point out which financial patents are more likely to be opposed and by whom. This evidence can help managers in elaborating their patenting strategies, increasing the probability of granting at the EPO, and economizing on post-grant litigation costs.

In conclusion, the explosion of patents in this field produces contrasting effects on social welfare. On the one side, the increased number of financial patents has induced more oppositions (and possibly more litigation costs as in the US) and may to some extent be a by-product of strategic patenting by large established computing firms. On the other side, financial patents open up new windows of opportunities for specialized technology firms. This trend is similar to what happens in other sectors such as security software and Q15 semiconductors (Hall and Ziedonis, 2001; Giarratana, 2007). In our future research we will explore more thoroughly the differences among the financial patents held by different types of firms. Moreover, we will examine the differences in patent exploitation strategies between specialized technology firms and vertically integrated firms. Our preliminary analysis shows that specialized technological firms are heavily involved in licensing out of their financial patents.

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Notes

1 Bernard Bilski's patent application for an invention relating to a method for hedging commodity price risk was rejected by the USPTO as relating to an abstract idea without practical application. The applicants have then appealed to the CAFC.

2 There is also an *inter-partes* re-examination system that was introduced in 1999, but until very recently, it has been rarely used.

3 Harhoff and Reitzig (2004) estimate that an opposition case typically costs each party between 15 and 25 thousand euros – only a very small part of which is accounted for by opposition fees (p. 450).

4 The term patent quality does not have a universally accepted definition, but we use it to mean an application that is more likely to satisfy the novelty, non-obviousness, and subject matter restrictions, and whose validity and ability to withstand subsequent challenges is therefore more certain (see Hall, 2003 for a discussion).

5 It is important to note that at the EPO, references to the patent and non-patent literature (scientific publications) are assigned by the examiner, not by the applicant. X-type citations refer to patents containing claims that overlap with claims in the patent under examination. Y-type citations refer to patent applications containing claims that combined with other claims overlap with claims in the patent examined.

6 That is, the patent has backward citations classified as X-type or Y-type by the EPO.

7 Later in the paper we do find that the opposition probability for financial patents is significantly higher than that for other patents (9% *vs* 6.5%, without correcting for the overall decline in opposition probability during the period; the correction would increase the difference slightly).

8 Class 705 is 'Data processing: financial, business practice, management, or cost/price determination' and subclass 35 is 'Finance (e.g., banking, investment, or credit).'

9 Although this clearly biases the selection toward firms operating in the US, because we use the union of this criterion with the other two (Sets B and C), we expect the bias to be small.

10 The precise definitions of the series shown are the following: All EP patents – patent grants and patent applications to the EPO; all US patents – patent grants by the USPTO; EP financial patents – the union of sets A, B, and C; EP business method patents – equivalents of US business method patents; US financial patents – the union of the sets defined by Hall (2007) and Lerner (2006); US business methods patents – all USPTO patents having at least one US patent class equal to 705 or 902 but excluding financial patents. All series are shown by priority year or application year if the priority year is not available.

11 There are a total of 3298 patents in our sample. Of these, 169 have more than one applicant (in a few cases more than two). In the next section we include all the patents, but only once each, so the total number of observations is 3298. In this section we focus on those applicants that were in the business sector, excluding individuals and government applicants, for a total number of observations equal to 2998, corresponding to 2934 patent documents, of which 52 have more than one applicant. Note that the 11 observations in which the sector of the applicant could not be identified were also removed from this sample.

12 In particular, we used Amadeus for European firms, Hoover's and Who Own Whom for US companies, Jade for Japanese

firms, and the company's websites for any firms not found on one of these sites.

13 The HTT index relies on the factor analysis for the construction of a synthetic indicator of patent value. For further information see Hall *et al.* (2007).

14 These periods are based on priority years, so there are too few granted patents in 2003–2005 to see much in the way of opposition. We therefore ended the detailed analysis at 2002.

15 The PCT dummy and family size are correlated because using the PCT route implies a desire to take out the patent in more than one country. Although the PCT coefficient is significantly negative, which will weaken the impact of family size, when it is removed, the coefficient falls only slightly (to 0.34).

16 There are no oppositions for the grants of financial patents with priority year after 2000, so we excluded those years from the analysis in the last column (53 observations).

17 However, doing things this way has the advantage of making both our estimates and standard errors consistent even if there are random firm effects. Given the large number of firms (over 1000) with only a single patent, using a fixed effect estimator is not very attractive as it would drop too many observations.

18 Since family size and the number of designated countries are correlated, in unreported regressions we tried with only one of these variables and the results do not change substantially.

19 In results not shown, when we combine the three ICT hardware sectors, we find that their probability of a grant is 0.15 higher than all other firms; the services sector probability is no different from that for other manufacturing firms.

20 In unreported regressions we entered a variable that measures the grant lag (the lag between the time of application and grant time) in the opposition equation. This variable has a negative and significant impact on the likelihood of opposition. This effect can be due to the fact that a long lag allows the patent office and the applicant to negotiate important modifications of the original application that prevent oppositions.

21 For patents held by business firms, there were 100 oppositions to 53 patents, as in Table 5.

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