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## **Need for speed? Exploring the relative importance of patents and utility models among German firms**

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## *Need for speed? Exploring the relative importance of patents and utility models among German firms*

Despite the wide use of two-tiered patent systems (patents and utility models), there is little empirical evidence about how often utility models (UMs) are actually used, what kind of firms use them to protect their intellectual property, and how firms rank them relative to patents. We offer such an analysis using data from Germany. We find that larger firms are more likely to use both protection methods. Moreover, a short life cycle of products and services is associated with an increased likelihood to use UMs. The features and functioning of the German utility model system are of broader interest because it has been a benchmark for several second tier patent protection systems around the world.

Keywords: patent; utility model; two-tiered patent system; intellectual property strategy; Germany

JEL Classification: O31; O32; O34

### **1 Introduction**

What kind of institutions and, in particular, systems of intellectual property rights (IPRs) should countries adopt in order to optimize the rate and direction of technological change and innovation? The patent system is arguably one of the most important innovation policy instruments, but its effect on the rate and direction of technological change, productivity growth, and, ultimately, citizens' welfare remains disputable (Mazzoleni and Nelson 1998; Kingston 2001; Moser 2005; Encaoua et al. 2006). Moreover, the importance of the patent system for a country's productivity growth, as an example, may be conditional on the country's level of development (Kim et al. 2012) and its institutions. Thus, it is unclear which type of IPR system is desirable and how its design ought to vary across different institutional contexts. A necessary step, therefore, in the search for an optimal IPR system and combination of innovation

policy instruments is to understand the functioning of instruments in a given institutional context. This paper's analysis builds on the premise that understanding why firms in a certain country prefer one IPR over another is at the heart of understanding the functioning of its IPR system.

Since its enactment in 1994, the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement introduced minimum standards for many forms of intellectual property (IP), rendering it the most comprehensive international agreement on intellectual property to date.<sup>1</sup> Despite progressive global harmonization efforts, there are still significant differences across national IPR systems. Some countries, such as Germany, for instance, have a two-tiered patent system comprising a patent and a utility model (UM) system, whereas many other countries have a system consisting of patents only. Additionally, TRIPS defines the minimum standards of patent systems and leaves further room for discretion in designing national patent systems (Suthersanen 2006; Königer 2009; Grosse Ruse-Khan 2012, 2013). However, since there are no international agreements on minimum standards of second tier patent systems, countries may design UM systems as they see fit. Although there are quite a few countries that possess dual-tier patent systems consisting of both patents and utility models, the average number of application is much lower for utility models in contrast to patents. This is mainly due to the distinct characteristics of patents and utility models. Table 1 illustrates some dimensions along which patent and UM protection typically differ.

TABLE 1 Comparison of patent and utility model protection

Notes: In some jurisdictions utility model applications are examined but typically there is just a registration process. Sources of information: WIPO; national patent offices; Janis 1999; Suthersanen 2006; Prud'homme 2014; Radauer et al. 2015.



Based on their distinct characteristics, UMs are usually described as a faster, cheaper, and simpler protection method than patents (e.g., European Commission 1995; Suthersanen 2006, Königer 2009, Radauer et al. 2015; Johnson et al. 2015).<sup>2</sup> As a result, UM systems in advanced economies are often justified by emphasizing their importance to small- and medium-sized enterprises (SMEs) and individual inventors. UM and second tier patent systems have, therefore, been claimed to foster minor inventions, which do not satisfy patentability requirements (Johnson 2002; Beneito 2006; Encaoua et al. 2006; Radauer et al. 2015; Grosse Ruse-Khan 2013). However, empirical evidence for these argued benefits is still scant, if not entirely lacking. For instance, Kim et al. (2012) did not find UM systems to be associated with economic growth in advanced economies.

Although both patents and UMs can be used to protect technical inventions, we currently have a limited understanding of the factors that are associated with the use of these protection methods. Additionally, some studies have investigated patenting strategies of small firms (de Rassenfosse 2012; Holgersson 2013; Maurseth and Svensson 2013) but the strategies to file for utility models remain underexplored. What determines a firm's decision to opt for patents or UMs (or both) and, hence, to choose between these appropriation mechanisms? While insightful, prior theoretical (Anton and Yao 2004; Kultti et al. 2007; Hall et al. 2013) and empirical (Arundel 2001; Hussinger 2006; Hall et al. 2013, 2014; Heger and Zaby 2013) studies have mainly focused on the trade-off between patents and secrecy as IP protection methods. Our paper contributes to the rather limited literature on UMs (reviewed in the next section) by exploring the determinants of firms' decisions to use patents and/or UMs and by identifying firm characteristics that are associated with the use and relative importance of patents and UMs. Inspired by Cao et al. (2014), we focus on the trade-off between UMs, which,

arguably, serve as appropriate protection methods for firms with a need to protect their inventions quickly (“need for speed”), and patents, which take more time to obtain, but are more reliable in case of infringement and provide longer-term protection.

Our data come from Germany and allow exploring what kinds of firms use UMs to protect their intellectual property and how firms rank them relative to patents. We have two main findings. First, larger firms are more likely to use both protection methods. On the one hand, the UM system is an inclusive institution by promoting protection of IP among resource-constrained small firms; on the other hand, it concurrently extends the arsenal of IPR methods for large firms. Second, a short life cycle of products and services is associated with an increased likelihood to use UMs. This suggests that UMs do not serve only applicants with incremental inventions, but also applicants in need of quick protection. These findings bear on the debate of the harmonization of IPR systems worldwide, as decision-makers involved in the design of IPR institutions need to understand the effects that two-tiered patent systems have on potential innovators and innovation activity. Such understanding is called for if international harmonization proceeds and, at some point, forces countries to decide whether or not to implement (or maintain) a second tier patent protection system.<sup>3</sup>

The paper is structured as follows: Section 2 reviews the related literature. The German UM system is described in section 3. In section 4, we discuss the possible determinants of the use of patents and UMs and develop testable hypotheses. Data and methods are presented in section 5 and the empirical analysis in section 6. Section 7 concludes.

## **2 Literature review**

Several studies and reports provide historical reviews and information on institutional details and justifications of national UM systems (European Commission 1995; Janis

1999; Suthersanen 2006; Königer 2009; Cummings 2010; Boztosun 2010; Grosse Ruse-Khan 2013; Prud'homme 2014; Radauer et al. 2015; Johnson et al. 2015). These studies and reports highlight three features of UM systems. First, national UM systems vary significantly across countries, as they are not internationally regulated or harmonized. Second, the stated justification of UM systems often refers to creating innovation incentives for SMEs and incremental innovations. Third, a frequently mentioned disadvantage of the UM systems is the legal uncertainty that they create in many jurisdictions as unexamined IP rights (no examination, only a registration process).

While UM systems have received some limited attention among legal scholars (e.g., Janis 1999; Suthersanen 2006; Björkwall 2009; Cummings 2010; Grosse Ruse-Khan 2012, 2013), research on the economics of UMs has been scarcer. In quantitative patent data analyses, it is common to treat UMs as patents (e.g., Hu and Jefferson 2009). Maskus and McDaniel (1999) found the Japanese UM system to have played an important role in the diffusion of technologies. They argue that the primary channels of diffusion were follow-up UM applications for incremental inventions, which built on prior technical knowledge embodied in patent applications. Johnson (2002) analyzes the interaction of “technology acquisition forms” (R&D and licensing) in the creation of new intellectual capital with Brazilian firm-level data. His results indicate that larger firms rely more on patents and less on utility models but otherwise the differences in determinants of patent and utility model applications are small. Beneito (2006) focuses on firm-level determinants of patent and UM use in Spanish research and development (R&D) intensive firms. She explicitly assumes patents and UMs to be measures of significant and incremental innovations, respectively, and found the number of patents to be associated with in-house R&D and UMs with contracted R&D. By using Korean data, Kim et al. (2012) show that UMs are positively associated with firm growth when

firms are technologically lagging. Kim et al. argue that such firms may use minor innovations protected by UMs as a learning device and as “a stepping stone for developing more patentable inventions later on” (2012, p. 358). Thomä and Bizer (2013) investigate combinations of IP rights utilized by SMEs in Germany using Community Innovation Survey (CIS) data. Although UMs are included in their analysis, Thomä and Bizer (2013) do not extensively discuss their role. It is, nevertheless, notable that, in their sample, SMEs in the “patent-oriented group” also assign a higher importance to UMs. This suggests that UMs are used as an auxiliary (i.e., complementary) protection method by patenting firms as highlighted by Radauer et al. (2015). This is particularly true for some jurisdictions, such as Germany, Finland, and Denmark, where patents and UMs can also be combined under certain conditions. This means that they are not necessarily mutually exclusive or substitutes (Guellec and van Pottelsberghe 2007; Prud’homme 2014; Radauer et al. 2015).

Lemley et al. (2005) further suggest establishing a gold plate patent system to supplement the normal patent system (i.e., two-tiered patent system), and, thus, eliminate bad (low probability of validity) patents in the US. Based on Lemley et al. (2005), Atal and Bar (2014) construct a theoretical model highlighting the role of two-tiered patent systems as signaling (or screening) devices. According to Atal and Bar (2014), introducing a second patent tier can reduce patent applications, decrease the number of bad patents, and increase social welfare: in a single-tiered system bad patents impose negative externalities to holders of “good” (high probability of validity) patents because they negatively affect the overall perception of patent quality. A two-tiered patent system enables screening and self-selection, which diminishes this negative externality. Importantly, Atal and Bar further claim that “since the two-tiered system

can be designed to mimic the best single-tiered system, welfare in an optimal two-tiered system is at least as high as welfare in the optimal single-tiered system” (2014, p. 522).

The disclosure function of the patent system aims to prevent duplication of R&D and allows rapid diffusion of innovations once the patent has expired (Mazzoleni and Nelson 1998; Johnson and Popp 2003; Denicolò and Franzoni 2004; Guellec and van Pottelsberghe 2007; Guellec et al. 2012; Graham and Hegde 2015). Accessible patent information enables other agents, especially competitors, to obtain information on the state of the art and technical advances in their field of technology (Arundel and Steinmueller 1998; van Zeebroeck and van Pottelsberghe 2011). UMs have the potential to further enhance welfare because technical information is published early on and normally much faster than in the case of patents. This means that knowledge spillovers may occur earlier.

### **3 Institutional framework**

#### ***3.1 The German utility model system***

In 1891, Germany introduced a UM system, rendering it the oldest UM system in the world, which is why it is often used as a reference for other countries (Kingston 2001; Guellec and van Pottelsberghe 2007). Initially, the aim of the German UM system was to fill the gap between patents and design rights, i.e., to offer protection for small technical inventions (Janis 1999; Grosse Ruse-Khan 2013). Harhoff et al. (2003), Cremers et al. (2013), and Cremers et al. (2014) provide good descriptions of the German patent system.

German UMs protect technical inventions, including chemical substances, food, and medical products, except processes (manufacturing and working processes, measuring processes, and others). The maximum duration of a patent is 20 years, while

a German UM can be extended for a maximum of 10 years. Although the UM is often referred to as a “petty patent” or “small patent”, in Germany the inventive step requirement has been the same for patents and UMs since 2006 (Björkwall 2009; Grosse Ruse-Khan 2013; Prud’homme 2014; Radauer et al. 2015).

Recent statistics on the UMs and patents in force in Germany, granted by the Deutsches Patent-und Markenamt (DPMA), show a slightly decreasing trend (as depicted in Figure 1). Moreover, Figure 2 indicates that the number of UM registrations is declining faster than the number of national patent applications. From 2000 to 2014, UM filings decreased by more than one-third (from 22,440 to 14,805), whereas patent applications increased by 1.7% (from 64,862 to 65,958). In contrast, the number of European Patent Office (EPO) patents granted in Germany has steadily been increasing: from 255,303 in 2000 to 458,042 in 2014 (79.4%). Part of the decrease in UM filings could be explained by the decision of the German Supreme court in 2006 to apply the same inventive step requirement for UMs as for patents.

Figure 1. Patents and utility models in force in Germany 2000-2014

Source: DPMA annual reports 2006-2014, available at:

<http://www.dpma.de/english/service/publications/annualreports/index.html>

Figure 2. Patent applications and utility model filings at the DPMA

Source: DPMA annual reports 2006-2014, available at:

<http://www.dpma.de/english/service/publications/annualreports/index.html>

The German UM system has been designed especially considering the needs of SMEs (Suthersanen 2006; Königer 2009; Grosse Ruse-Khan 2013). The procedure to register a UM at the German patent office is simpler and somewhat cheaper than the

procedure to apply for a patent. This is reflected by statements made by the largest IP law firms and patent attorneys, as well as the Industrie-und Handwerkskammer (IHK) in Germany;

“Due to a lack of examination it is significantly faster and more cost-effective to obtain a utility model, on the other hand, this makes it less legally secure.” (IHK München)<sup>4</sup>

“A utility model is due to the low costs, especially suitable for small and medium-sized businesses (SMEs) as well as for inventions, for which is not yet known whether or how they are economically exploited.” (Wittmann and Hernandez, patent attorneys)<sup>5</sup>

Additionally, Radauer et al. (2015, pp. 32-33) report six beneficial features of German UMs that stand out in the qualitative feedback from UM users: 1. speed of protection, which makes UMs suitable for products with short life cycles; 2. branching-off a UM from a patent application; 3. protection for minor inventions; 4. grace period; 5. complying with German employee inventions law; and 6. using UMs as a cheap means for publication (create prior art and preserve freedom to operate). Hence, the UM adds flexibility to the German patent system.

### ***3.2 The process of registering a utility model in Germany<sup>6</sup>***

The examination and granting of a patent usually take several years. In Germany, the applicants also have the option for deferred examination, i.e., to postpone examination of the patent for a maximum of seven years (Harhoff et al. 2003; Jell et al. 2013; Harhoff et al. 2015). In contrast, a German UM is registered on average within two to four months after filing the application (Radauer et al. 2015), provided the documents filed comply with the provisions of the Utility Model Act (Gebrauchsmustergesetz). The DPMA itself advertises UMs as “the fast IP rights”.<sup>7</sup>

Table 2 reports descriptive statistics for German patents and UMs concerning pendency times and publication lags.<sup>8</sup> The mean grant lag of patents and the registration lag of UMs are affected by right-skewed lag distributions as the median lags are considerably shorter than the respective means.<sup>9</sup> From 2000 to 2010, the median grant lag for German patents was 2.8 years, while for UMs, the median registration lag was approximately three months.

Table 2. Publication, registration, and grant lags of patents and utility models

Figure 3 shows the grant lag distribution of patents and Figure 4 the registration lag distribution of UMs. Interestingly, the distribution of UM publication lags is bimodal. As mentioned in the previous section, it is possible to postpone the publication of UMs by 15 months, and Figure 4 suggests that this option is exercised in a considerable number of UM filings.

Figure 3. Grant lag distribution of German patents from 2000-2010

Notes: Data source is the PATSTAT 2016 April edition. All priority patents were filed at the German patent office from 2000-2010. PCT filings are excluded.

Figure 4. Registration/publication lag distribution of German utility models from 2000-2014

Notes: The data are based on the PATSTAT 2016 April edition and cover all priority UMs filed at the German patent office from 2000-2010. Outliers, UMs with longer than 700 publication lags, are not reported, and PCT filings are excluded.

A major strategic concern in patenting relates to the role of disclosure and the timing thereof. After having filed a patent, the application will be kept secret for 18



months and will then be published. The mean and median publication lags of patents reported in Table 2 are almost exactly 18 months (540 days). The published patent application will be available in the openly accessible DPMAregister database from the first publication date.<sup>10</sup> Figure 5 depicts the publication lags of patents. The 18-month secrecy period does not apply to UMs. Instead, if a UM application does not have any defects, or if the defects have been remedied, the UM is entered into the DPMAregister, and, hence, its contents become public knowledge.<sup>11</sup> For UMs, the publication date is the same as the registration date.

Figure 5. Publication lag distribution of German patents from 2000-2014

Note: Data source is the PATSTAT 2016 April edition. All priority patents filed at the German patent office from 2000-2014. Outliers, patents with longer than 700 publication lags, are not reported, and PCT filings are excluded.

In Germany, a UM becomes effective upon registration and gives the same right to exclude others from using, producing, and marketing the protected invention as a patent. This makes it a potentially appropriate protection method for inventions whose owner needs quick enforcement against potential imitators. Patent applications, on the other hand, cannot be enforced when they are pending. Thus, while UMs can only be in force for 10 years, the difference in potential effective life (from grant to expiration) compared to patents is decreased by the fast grant.<sup>12</sup> Nonetheless, a UM is an unexamined IP right as it lacks substantive examination: patent examiners at the DPMA do not examine the novelty, inventive step, and industrial applicability of the invention prior to its registration. Therefore, inventors should conduct thorough searches to ensure that the application actually meets the requirements that apply to effective IP rights. Unexamined IP rights comprise inherent legal uncertainty (Suthersanen 2006; Königer 2009; Prud'homme 2014; Radauer et al. 2015). Weak patents may be socially costly as

they can create the danger of patent hold-up, lead to costly litigations, and induce a vicious cycle of defensive patenting (Farrell and Shapiro 2009; Atal and Bar 2014).

A peculiarity of the German UM system is the novelty grace period: If an inventor applies for a UM registration within six months from the publication of her invention, UM protection is still available (Radauer et al. 2015). The patent systems of the US, Japan, and Canada apply grace periods, but European patent systems have not applied grace periods since the European patent convention was signed in 1973 (Franzoni and Scellato 2010). This means that, in most European patent systems, publication of an invention destroys its novelty and a patent can no longer be granted (Franzoni and Scellato 2010). In Germany the grace period of UMs enables inventors to protect their disclosed inventions with UMs.

Moreover, in Germany, there is the possibility for double granting, i.e., an applicant can protect the same invention with both a patent and a UM (Guellec and van Pottelsberghe 2007; Prud'homme 2014; Radauer et al. 2015). Splitting-off<sup>13</sup> a UM provides protection in the period between patent application and grant, when no or only limited protection is available.<sup>14</sup> By making a respective splitting-off declaration, an applicant may obtain an independent UM application, for which it is possible to claim the priority date from the patent application. Upon registration of the split-off UM, the invention enjoys full protection (a right to injunctive relief and claim for damages), irrespective of the outcome of the patent grant procedure. Hence, with complementary UM protection, it is possible to extend patent protection from the front end. Figure 3 provides an overview of patenting and UM processes in Germany and illustrates the gap in the time dimension of patent protection which the UM protection is filling.

Figure 6. Patenting and UM registration processes in Germany

Although German UMs (and patents) are presumed valid until proven otherwise, the bifurcation principle (infringement and validity of a patent are decided independently by different courts) does not apply to UMs (Cremers et al. 2013; Cremers et al. 2014). In UM disputes, the defendant is allowed to raise the invalidity defense (Cremers et al. 2013), whereas this is not possible in patent suits. Then, cancellation proceedings will clarify whether the UM is actually valid, i.e., that the invention is new and involves an inventive step.<sup>15</sup> The UM infringement suit is then suspended until the resolution of cancellation proceedings.<sup>16</sup>

#### **4 To patent or to register a utility model, or both?**

In this section, we discuss the possible determinants of the use of patents and UMs and develop testable hypotheses. The hypotheses are derived from the prior literature and economic theory, but they also mirror the particularities of the institutional context in which the firms in our data operated.

Economic theory suggests that firms' IPR decisions are based on profit maximization and that firms take into account the prevailing IPR institutions when making those decisions. Surveys of patenting firms suggest that firms use patents for different strategic purposes (e.g., preventing imitation, securing freedom to operate (FTO), licensing, signaling capabilities to acquire funding, blocking, and pre-empting), and that these motives may differ by firm size and industry (Cohen et al. 2000; Blind et al. 2006; de Rassenfosse 2012; Holgersson 2013). Presumably, the motives to use UMs should be similar to those of patents, as they are also a protection method for technical inventions. The two main differences between the German patents and UMs relate to the speed of protection and to the threshold of obtaining protection. However, the benefits and costs of using patents and UMs are expected to vary depending on firm

characteristics. Next, we develop hypotheses concerning the choices between UMs and patents.

#### ***4.1 Economies of scale and scope in the use of IPRs***

Larger firms can benefit from economies of scale (Cohen et al., 2000) and learning when it comes to filing and using a particular type of IPR. They can spread the fixed costs of IPR activities over a larger number of innovations. In comparison to small firms, established firms have the financial capacity to develop internal R&D capabilities that generate more valuable innovations and, thus, patents with greater economic benefits (“valuable patents”) (Johnson 2002; Allison et al. 2004; Harhoff et al. 2003; Hussinger 2006). They also often have an in-house R&D and/or IP department that is routinized in using the patent system (Hussinger 2006; Wagner 2006; Wang et al. 2009; Grimpe and Kaiser 2010), whereas smaller firms possess fewer resources that they can invest in IP protection (Wernerfelt and Karnani 1987; Byma and Leiponen 2009).

There is no reason to expect that only small firms would use UMs, as it is unclear why large firms would not also want to register UMs to supplement their patent portfolios. Larger firms have the resources to invest in many kinds of R&D projects simultaneously, which increases their chances of discovering protectable inventions (Johnson 2002; Harhoff et al. 2003; Allison et al. 2004). Such inventions can be incremental or more radical. Moreover, larger firms often have more product lines than small firms and, thus, a larger variety of potentially protectable technical inventions. Large firms have more resources and capabilities to utilize many kinds of IPR methods, which may lead to economies of scope. They can protect more valuable inventions with patents and register UMs for less valuable inventions (Beneito 2006). In Germany, it is possible that inventions are protected with both a patent and a UM because the legislation allows double granting (Guellec and van Pottelsberghe 2007; Prud’homme

2014; Radauer et al. 2015), as was explained in the previous section. Hence, the larger a firm is, the more likely it is to have several product inventions, some of which they protect with patents and some with UMs.

*Hypothesis 1: The likelihood to utilize patents and utility models simultaneously in protecting IP increases with firm size.*

#### **4.2 Need for speed**

The DPMA states that UMs can be granted as quickly as four days after application and that they are typically granted in three to four weeks if a patent attorney is involved and, on average, in three months if no patent attorney is involved (Prud'homme 2014, p. 20). In contrast, Harhoff et al. (2015) report that the average duration of a patent examination at the DPMA was 2.6 years during the period from 1989 to 1996. Table 2 and Figures 2 and 3 in section 3.2 depict the difference in patent grant lag and UM registration lag distributions for the population of German priority filings from 2000-2010. The speed advantage of UMs compared to patents in obtaining protection for technical inventions is considerable and counted in years, rather than months (see Table 2).

Radauer et al. (2015) have recently conducted a survey of UM users in Germany and find fast protection to be the most important motive to register UM among the 47 respondents. Furthermore, Radauer et al. (2015, p.32) report the most useful feature of UMs, which stood out in interviews with IP professionals and UM users, was speed: “Foremost to mention is speed. UMs are granted quickly and can be used particularly well for products that have a short product life cycle.” Hence, an important difference between patents and UMs lies in the time dimension of protection: patents offer slower but longer protection, whereas UMs offer fast but shorter protection (Cao 2014).

Previous literature has defined the length of the product life cycle (i.e., product lifetime) as the time between a product's introduction and withdrawal from the marketplace (Bayus 1994, 1998).

Particularly in dynamic industries, firms may rely more on informal protection methods, such as lead-time and secrecy, than on the slower patents (Cohen et al. 2000; Arundel 2001; Byma and Leiponen 2009; Thomä and Bizer 2013; Hall et al. 2014). Therefore, we expect firms operating in markets with short life cycles of products and services to be more likely to use UMs and rate a higher importance to UMs relative to patents.

*Hypothesis 2a: Firms reporting to have short life cycles of products and services are more likely to use utility models than other firms are.*

Based on the arguments above, we developed a stated preference version of the previous hypothesis:

*Hypothesis 2b: Firms reporting to have short life cycles of products and services assign higher importance to utility models.*

It is possible that, in dynamic and fast-moving markets characterized by intense competition, the risk of overlapping invention is higher, irrespective of the life cycle of products. In this situation, firms require strong protection and may, therefore, prefer patents to uncertain UMs. Additionally, firms rarely possess "one patent per product". Hence, even though product life cycles might be short, the underlying patented technology might still be applicable to new products; therefore, it would be rational to patent and protect inventions against competitors. If this reasoning were correct, then the association between short life cycles and the choice of UMs would be confounded.

## **5 Data and methods**

In this section, we present the data for analysis, the choice and construction of dependent and independent variables, and the estimation methods which we apply to test our hypotheses.

### ***5.1 Data sources***

We use the Mannheim Innovation Panel (MIP) 2005, MIP2005, which includes the core Eurostat Community Innovation Survey (CIS) questions and a few additional country-specific questions. Previously, Thomä and Bizer (2013) utilized these data to study the innovation protection mechanisms of small German firms. They also provide a detailed description of how the MIP2005 data were collected. The questions in the MIP2005 refer to the three-year period from 2002 to 2004. Thus, the survey considers the period before the 2006 German Supreme Court's decision to abolish the inventive step difference between patents and UMs. As shown in Figure 1, it seems that this legal change led to a slight, but not dramatic, decrease in the level of UM applications. The random sample of German firms is stratified by region, size, and sector. The survey contains information about the perceived business environment and firm characteristics, enabling us to test the developed hypotheses. Most importantly, the questionnaire includes questions about the protection methods that firms used to protect their intellectual property (IP).

### ***5.2 Variables***

#### ***5.2.1 Dependent variables***

We measure how firms use UMs and patents and their stated ranking ("stated preference") of these two methods of IP protection. We, therefore, construct two

alternative dependent variables for our empirical analysis.

The relevant questions in the MIP2005 ask whether the respondent firm had used the listed formal protection methods (patent, utility model, design right, trademark and copyright) to protect their IP during past three years.<sup>17</sup> We construct binary variables to indicate the use of patents (P) and UMs:

$$Use_i^j = \begin{cases} 1, & \text{if firm } i \text{ used protection method } j \text{ to protect IP 2002 – 2004,} \\ 0, & \text{otherwise} \end{cases}$$

where  $j \in \{P, UM\}$ .

Conditional on using a specific IP protection method, the respondents were also asked to rate the importance of the respective method on a three-point Likert scale: low importance, medium importance, and high importance. We assume that firms which did not use a specific protection method are considered to assign the lowest possible importance i.e. no importance to the protection method. Hence, we construct the following dependent variable when modelling the stated importance of protection methods in protecting IP:

$$Imp_i^j = \begin{cases} 0, & \text{if } Use_i^j = 0 \\ 1, & \text{if firm } i \text{ reports } j \text{ to be of low importance} \\ 2, & \text{if firm } i \text{ reports } j \text{ to be of medium importance} \\ 3, & \text{if firm } i \text{ reports } j \text{ to be of high importance,} \end{cases}$$

where  $j \in \{P, UM\}$ .

### *5.2.2 Independent variables of key interest*

We measure firm size by logarithm of reported full-time equivalent employees in 2004,  $\log(\text{Employees})$ . Short life cycle of products and services is proxied with a binary variable D (Short life cycle), which obtains value 1, if a firm totally agrees or agrees<sup>18</sup>



that in its main market “products/services mature rapidly,” and 0 otherwise (cf. Thomä and Bizer 2013). We acknowledge that product and service life cycles differ across industries and that, in the survey, the term “rapidly” is subjectively interpreted. If D (Short life cycle) contains a high measurement error due to subjective interpretations (and, therefore, does not systematically measure how rapidly the products of firms mature and become obsolete), we are less likely to find evidence consistent with Hypotheses 2a and 2b.

### *5.2.3 Control variables*

We control for the following firm characteristics. Firms’ R&D investments are controlled for with the total R&D expenditure divided by fulltime equivalent employees. Since higher R&D intensity is likely associated with greater innovative output, i.e., more potentially patentable inventions, by holding R&D intensity constant, our independent variable logarithm of firm employees is a measure of economies of scale. We measure the importance of exports for each firm by exports per sales. Exporting firms need to be aware of national differences in IPR systems (Ginarte and Park 1997; Park 2008) in their target markets which could increase the relative importance of patents as all countries have patent systems, but a smaller share have UM systems (Kim et al. 2012). Group membership indicates whether a firm is a part of a larger group of firms. Firms that are part of a larger group, i.e., a conglomerate, may be able to leverage the knowledge and capabilities of their conglomerate to exploit IPR systems. The most robust finding in prior studies on the motives to patent is that the use differs across industries (Cohen et al. 2000; Arundel 2001; Hall et al. 2014). Furthermore, Johnson and Popp (2003) report varying grant lags across technologies. Therefore, to control for industry and technology heterogeneity, we include seven technology class dummies. We follow Eurostat’s high-tech classification of

manufacturing industries (high tech, medium high tech, medium low tech, low tech) and knowledge-intensive business services (knowledge-intensive businesses, low knowledge-intensive businesses).<sup>19</sup> The seventh technology class consists of NACE Rev. 1.1 industries 40 (electricity, gas, steam, and hot water), 41 (supply, collection, purification, and distribution of water), and 45 (construction).

### 5.3 Econometric models

Our data are cross-sectional. We model the use and importance of patents and UMs as follows. First, we examine which firm characteristics are associated with the use of patents and UMs by estimating a bivariate probit model (Greene 2012, pp. 778-781).

The bivariate probit model is appropriate for modeling joint determination of patent and UM use, as they are presumably interrelated.

$$\text{Use}_i^{*,j} = \alpha^j + \beta_1^j \log(\text{Employees}_i) + \beta_2^j D(\text{Short life cycle}_i) + \delta' \mathbf{x}_i + \theta_k + \varepsilon_i^j,$$

$$\text{Use}_i^j = 1 \text{ if } \text{Use}_i^{*,j} > 1, 0 \text{ otherwise}$$

$$\begin{pmatrix} \varepsilon_i^P \\ \varepsilon_i^{UM} \end{pmatrix} \Big| \log(\text{Employees}_i), D(\text{Short life cycle}_i), \mathbf{x}_i \sim N \left[ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right],$$

where  $j \in \{P, UM\}$  and firm  $i$  belongs to technology class  $k$ ,  $x$  is a vector of controls,  $\rho$  is the correlation between error terms, and, if  $\rho = 0$ , then the bivariate probit becomes two independent univariate probit models (Greene 2012, p. 782). If  $\rho \neq 0$ , then there exists a disturbance correlation between the two equations, i.e., the unobservables affecting the concurrent choice of patent and UM use are correlated. In this case,

bivariate probit gives more efficient parameter estimates than separate probit models, which assume disturbances to be independent.

Second, we study the interrelated importance of patents and UMs by estimating a bivariate ordered probit model which is a direct extension of a univariate ordered probit model (Greene and Hensher 2010). The model is the same as the above-presented bivariate probit model except that the dependent variable is now an ordinal variable indicating the importance of patents and UMs (see section 5.2.1).

We are not claiming any causal relationships, but we try to identify statistical associations between firm characteristics and the use and importance of IP protection methods. In particular, we are not investigating the decision to start using a specific IP protection method, but rather the prevailing status of a firm in utilizing IP protection methods (during the past three years, i.e., 2002-2004). The firms that have been innovative in the past may or may not have chosen to protect their inventions with patents or UMs or both.<sup>20</sup> Therefore, we did not want to narrow our baseline sample and estimations to only recently innovative firms (i.e., firms that introduced innovation from 2002 to 2004) or to R&D active firms (firms with R&D investments from 2002 to 2004).

We acknowledge that the firms may have protected their inventions and IP with several other protection methods than UMs and patents (cf. Thomä and Bizer 2013). In order to be concise, we leave them out of the current analysis and focus on the relationship between patents and UMs.

## **6 Empirical analysis**

### ***6.1 Descriptive analysis***

Table 3 presents the descriptive statistics by the categories of patent and UM users. A

total of 75% of our sample firms (2,265/3,016) used neither patents nor UMs to protect their IP. These firms are the smallest, invest the least in R&D, and are the least export-intensive, on average. A quarter of these firms report having short product and service life cycles. A minority, 4.2% (127/3,016), of the sample firms use UMs only. These firms are smaller on average, invest less in R&D per employee, and have a lower export share of turnover than patenting firms.

In line with the need for speed Hypothesis 2a, UM users (36.2%) frequently report short life cycles of products and services, although the differences between these users and both patent only users (32.1%) and patent and UM users (35.5%) are small. Consistent with the economies of scale and scope Hypothesis 1, the firms which use both protection methods to protect IP are large and, on average, have the most employees. Firms using patents only have, by far, the largest mean R&D expenditure.

#### Table. 3 Descriptive statistics

Figure 7 illustrates how the use of patents and UMs is associated with firm size categories measured by the number of employees. Firms are classified into three categories based on number of employees: 1-49 employees, 50-249 employees, and more than 250 employees. The majority of sample firms do not use any protection methods in all size categories. The share of firms utilizing both protection methods increases with firm size. This observation is in line with the economies of scale and scope Hypothesis 1, although it should be noted that the industry composition is likely to differ between size categories. Similarly, the share of firms using only patents increases with firm size, whereas the proportion of firms using only UMs is the largest among medium-sized (50-250 full-time equivalent employees) enterprises (5.5%). The small proportions of firms using only UMs in all size categories indicates that UM

protection is a supplemental protection method for patenting firms rather than a main protection method on its own.

Figure 7. The use of protection methods by firm size (employees) categories

Note: Firms are classified into three size categories: 1-49 employees, 50-249 employees and more than 250 employees.

Figure 8 shows that those firms that have short life cycles of products or services are more active users of patents and UMs. Among firms which have short life cycles of products and services, 16.1% used UMs to protect intellectual capital, whereas, among firms which did not report short life cycles of products or services, 11% used UMs. This is consistent with Hypothesis 2a.

Figure 8. The use of protection methods by “need for speed”

## ***6.2 Econometric results***

### *6.2.1 The use and importance of patents and utility models*

First, we estimate a bivariate probit model to analyze the determinants of concurrent patent and UM utilization. Table 4 reports the estimated coefficients (columns 1-2) and marginal effects (columns 3-6).

Table 4. The use of protection methods, bivariate probit model

Notes: The dependent variables are indicator variables for the use of patents and utility models. First two columns report the estimated coefficients for bivariate probit model. Columns 3-6 present the marginal effects at means for patent and utility model

combinations. Heteroscedasticity robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Regarding the combined use of patents and UMs, we find support for our economies of scale and scope Hypothesis 1: firm size is positively associated with the likelihood to use both protection methods (columns 1 and 2). The observation is consistent with prior literature, which suggests larger firms to be more capable users of formal protection methods (Cohen et al. 2000; Hussinger 2006; Byma and Leiponen 2009; Hall et al. 2013; Thomä and Bizer 2013). Firm size is also positively associated with the likelihood to use only patents (column 4) and only UMs (column 5), but the estimated marginal effect is the highest in the case of concurrent use of both protection methods. Moreover, in line with Hypothesis 2a, the estimates of Table 4 suggest that a short life cycle of products and services is associated with an increased likelihood to use only UMs or both patents and UMs. In line with our expectations, the association is more pronounced between short life cycles and the use of only UMs, an increase of 2.3 percentage points (column 5), than between short life cycles and the use of patents and UMs, an increase of 1.5 percentage points (column 3).

A statistically significant positive  $\rho$ , i.e., the correlation of error terms, indicates that the uses of patents and UMs are not independent of each other, conditional on the included covariates.<sup>21</sup> Furthermore, a positive  $\rho$  is in line with the view that patents and UMs are complements rather than substitutes.

The signs of control variables are in line with our expectations. We find R&D per employee to be positively associated with the likelihood to use patents and both protections methods. This is in line with the expectation that more important and costly inventions are protected with patents, whereas UMs are appropriate protection methods for incremental improvements (Johnson 2002; Beneito 2006; Kim et al. 2012). The

analysis of marginal effects indicates that the positive association between R&D and the likelihood to use utility UMs is, in particular, driven by firms that use both patents and UMs, rather than by firms that use only UMs, since the estimated marginal effect for the former is more than six times larger than that of the latter.

The observed positive association between export intensity and the likelihood to use patents or both protection methods is consistent with the fact that exporting firms need to protect their inventions in target markets which more often have regular patent systems than two-tiered patent systems (e.g., the US and the UK) (Kim et al. 2012). The non-significant association between export intensity and likelihood to use only UMs highlights the importance of the UM system for firms mainly operating in Germany. It is likely that German firms which export within the EU protect their inventions with European patents granted by the EPO.

Next, we explore the factors associated with the stated importance of patents and UMs. Table 5 shows the results of the bivariate ordered probit estimation. Generally, the estimates corroborate our findings about the use of patents and UMs presented in Table 4. The need for speed Hypothesis 2b is supported as we find short life cycles of products and services to be associated with the importance of UMs, but not with the importance of patents. Again, the statistically significant positive  $\rho$  suggests that there exists a disturbance correlation between the equations, i.e., the reported importance of patents and UMs are related. Again positive  $\rho$  indicates that patents and UMs are complements rather than substitutes. The signs of the estimated coefficients of the control variables are similar between the bivariate probit model in Table 4 and the ordered probit model in Table 5: firm size, R&D intensity, and export intensity are all positively and significantly associated with the importance of both patents and UMs. Thus, the use and importance of protection methods are closely linked, as expected.

Table 5. The stated importance of UMs and patents, bivariate ordered probit model

Notes: The dependent variables are ordinal variables indicating the importance of patents and utility models as IP protection methods. 12 firms, which reported to use patents and/or utility models but did not answer the importance question, are omitted. Heteroscedasticity robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

### *6.2.2 Robustness checks*<sup>22</sup>

First, various prior studies which have utilized CIS data have focused on subsamples of “recent innovators” (e.g., Hussinger 2006; Thomä and Bizer 2013; Hall et al. 2013). Hence, we re-estimated the use of protection method models (Table 4) for the subsample of innovating firms (ones that introduced a product or process innovation during 2002-2004). The results are reported in Table A.1 in the Appendix. As in Table 4, we find firm size to be positively associated with the use of patents and UMs, and the estimated marginal effects are of similar magnitude. Also, short life cycles of products and services are found to be positively associated with the use of only UMs. The estimated marginal effects provide weak support that having a short life cycle of products and services is negatively associated with the use of patents only. In the case of the importance of patents and UMs, when we restrict the sample to innovators, we still find firm size to be positively associated with the use of patents and UMs. The positive association between UMs and short life cycles of products and services is also found, but the effect is somewhat weaker statistically.

Second, since UMs are arguably somewhat cheaper to acquire than patents (Königer 2009), we control for reported financial constraints, i.e., if the firm reported lack of financing (internal or external) to be an obstacle for innovation. Another reason to control for financial constraints is that patents may be more important than UMs in convincing investors (especially international investors who may not be equally familiar



with UM protection) and acquiring financial resources (Mann and Sager 2007; Hoenen et al. 2014; Hoenig and Henkel 2015). We also control for the level of competition in the firm's main market.<sup>23</sup> The association between competition and the use of patents and UMs is unclear. On the one hand, stronger competition may induce firms to "escape competition" by innovating (Aghion et al. 2005) and by protecting their IP more intensively. On the other hand, more intense competition in fast-moving markets may induce firms to forego IP protection altogether and focus on lead time advantages. Nevertheless, the results are robust for these controls on financial constraint and competition; firm size remains significantly positively associated with the use of and importance of patents and UMs. Short life cycle of products and services is also found to be positively associated with the use and importance of UMs, but not with the use and importance of patents. Hypothesis 2a, concerning the positive significant association between short product life cycle and the likelihood to use (only) UMs, gets further support.

Interestingly, we find a statistically significant positive association between the reported financial constraints and the use and importance of patents and no association with the financial constraints and the use and importance of UMs (Columns 1 and 2 in Table A.3). In particular, having financial constraints is positively associated with the likelihood to use only patents and not UMs (Column 4 in Table A.3). It is estimated that firms reporting financial constraints are 1.9 percentage points more likely to use only patents than firms which do not report financial constraints. This could be in line with the view that patents are more important than UMs in acquiring external financing, as firms signal the quality of their invention with patents (Mann and Sager 2007; Hoenen et al. 2014; Atal and Bar 2014; Hoenig and Henkel 2015). On the other hand, it could also indicate that patents protect more significant inventions which require additional

financing for further development and commercialization. Nevertheless, our results do not support the view that financial constraints push firms to protect their inventions with “cheap” UMs instead of “expensive” patents.

Although none of the estimated coefficients for competition categories is statistically significant in Tables A.3 and A.4, the signs suggest a pattern that having zero competitors is associated with a lower likelihood to use patents and UMs than having more than 15 competitors (the reference group in estimations), whereas having 1-15 competitors is associated with a higher likelihood to use patents and UMs. This is consistent with the “escape competition effect” and in line with the inverted U-shaped association between competition and innovation (Aghion et al. 2005).

### *6.2.3 Limitations*

An important limitation of the study is the focus on firm-level instead of invention-level utilization of patents and UMs (Hussinger 2006; Hall et al. 2013; Heger and Zaby 2013). In reality, patent and UM protection are utilized at the invention level (i.e., project -level) and different inventions require different protection as they might be of a different inventive step and have life cycles of a different length. Thus, when a firm has several product lines and services, the stated use and importance of IP protection methods probably reflect the overall importance of separate protection methods, i.e., “aggregated preferences.” In other words, firms with multiple product lines and services may have short life cycles in their main market, but use patents and UMs to protect complementary products. Thus, although we control for R&D intensity per employee and firm size, the patterns that we observe might be driven by omitted variable bias: the number of product lines and services.

One source of bias is that our measure for short life cycle of products is a coarse proxy and is subjectively assessed by survey respondents. It is likely that this leads to

attenuation bias, i.e., the estimated coefficient for short life cycle indicator is biased towards zero. Another possible source of bias is reverse causality: firms that are innovative protect their inventions with patents and UM, which gives them competitive advantage and helps them grow. Thus, the association between firm size and the use of patents and UMs is an endogenous process. Consequently, our estimates of this association are likely to be biased upwards. With the current data, we are not able to account for this endogeneity problem.

Our study focuses on a period before the German Supreme Court 2006 decision to abolish the inventive step difference between UMs and patents. Therefore, the external validity of our results might be diminished since the current German system is different from the system prior to the decision. As shown in Figure 2, the legal change did not lead to a sudden drop in UM filings, indicating that the lower inventive step requirement has not been the dominant motive to file UMs. Moreover, Figure A.1 in the Appendix shows that the registration lags of German UMs have been consistently shorter than grant lags of German patents even after the 2006 amendment. These observations are in line with Radauer et al.'s (2015) finding that the speed of protection was mentioned as the most important motive to file UMs, instead of protection for minor inventions. However, an important topic for further research is to analyze how the use of German UMs has evolved over time and how legal changes have affected filing activity.

## **7 Discussion and conclusion**

We study the use and the relative importance of patents and UMs among German firms. The results suggest that larger firms tend to take advantage of both patent and UM systems. These observations indicate economies of scale and scope and are consistent with the view that larger firms have more resources and capabilities to exploit IPR

systems. Furthermore, in line with the publicly expressed justification of the German UM system as “fast IP right”, we find short life cycles of products and services to be associated with the use and stated importance of UMs.

Our study is related to the ongoing process of harmonization of IPR systems within the European single market (see European Commission 2011). Obviously, differences in national IPR systems increase transaction costs. Thus, it is likely that, for many inventors and SMEs, the patent system remains too complex and expensive and, therefore, hardly accessible. In this type of environment, larger and more experienced firms have the upper hand. In addition to a deepening harmonization of IPR systems in Europe and across the world, policy could focus on increasing the awareness of UMs as alternative protection methods and concurrently avoid an IPR environment that is excessively complex for SMEs and individual inventors. Especially firms and inventors from those EU member states which do not provide UM protection might be unaware of the UM option in other EU member states. In contrast, firms and inventors from the EU member states with UM systems are likely to gain a better understanding of the (dis)advantages of utility models relative to patents as legal protection mechanism. Hence, increasing the awareness of national IPR protection methods remains of the utmost importance in leveling the playing field between firms in the European single market.

Two-tiered patent systems provide a variety of interesting theoretical and empirical questions which have yet to be answered. A natural way to deepen the analysis of the relative importance of patents and UMs is to study patenting behavior with patent and UM data (e.g., PATSTAT) which are linked to data on applicant characteristics. As large firms seem to be active users of the UM system, an important topic for future research is how the UM system affects industry dynamics and

competition between large incumbents and smaller entrants. Future studies could also investigate the underlying strategic motives to use UMs and how these motives vary across countries and industries.

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## **Notes**

1. The Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement is Annex 1C of the Marrakesh Agreement Establishing the World Trade Organization, signed in Marrakesh, Morocco on 15 April 1994. See:  
[https://www.wto.org/english/docs\\_e/legal\\_e/27trips\\_01\\_e.htm](https://www.wto.org/english/docs_e/legal_e/27trips_01_e.htm)
2. UMs are often considered a low cost alternative to patents due to lower administrative and maintenance fees. However, Radauer et al. (2015) point out that the cost savings aspect of UM might be overstated because administrative costs are only a small part of total patenting costs; in practice, patent attorneys are frequently hired to draft applications, and their fees are much higher than administrative application costs. See also van Pottelsberghe and Francois (2009) and Königer (2009).
3. In Europe, the harmonization of IPR systems has been a top priority (see European Commission 2011), but national UM systems have been ranked low on the agenda since the European Union member states suspended the proposal for a “community utility model”(European Commission 1995) in March 2000 (European Commission 2002). However, after the unitary patent system is in place and working, it is likely that more attention will be directed to the harmonization of national UM systems.
4. <https://www.muenchen.ihk.de/dc/recht/patentrecht-designschutz/welcher-schutz-fuer-was-/patent-und-gebrauchsmusterrecht> Accessed on 28 January 2016.

5. [http://www.wh-ip.de/patentanwalt/gebrauchsmuster\\_anmelden.html#allgemeine\\_informationen](http://www.wh-ip.de/patentanwalt/gebrauchsmuster_anmelden.html#allgemeine_informationen) Accessed on 28 January 2016.
6. This section is mainly based on information retrieved from the DPMA's webpage.
7. [http://dpma.de/english/utility\\_models/index.html](http://dpma.de/english/utility_models/index.html) Accessed on 25 September 2015.
8. The source of data is the PATSTAT April 2016 edition. Populations consist of German priority patent and UM filings. PCT applications are excluded.
9. We report the grant lags for 2000-2010 instead of 2000-2014 due to a truncation problem: the more recent a patent filing is, the more likely it is still pending and does not enter grant lag mean and median calculations. See Figure A.1 in the Appendix.
10. <https://register.dpma.de/DPMAREGISTER/Uebersicht?lang=en> Accessed on July, 13, 2015.
11. Upon request, publication of the UM can be postponed for up to 15 months beginning from the filing date, but, of course, protection commences with publication of the UM. See §§ 8 Abs. 1 GebrMG, 49 Abs. 2 PatG. See also: [http://www.wh-ip.com/germany/german\\_utility\\_model.html](http://www.wh-ip.com/germany/german_utility_model.html) Accessed on July 13, 2015.  
[http://www.vo.eu/en/news/item/476/german\\_utility\\_model\\_alternative\\_to\\_national\\_patent](http://www.vo.eu/en/news/item/476/german_utility_model_alternative_to_national_patent) Accessed on July, 13, 2015.
12. In practice, the duration of most patents is also less than 20 years, since, in many cases, applicants let patents lapse by not paying the renewal fees (Guellec and van Pottelsberghe 2007; Harhoff et al. 2015). Guellec and van Pottelsberghe (2007) report that 50% of patents granted by the EPO lapse within first 10 years and only 8% of EPO patents are renewed until the statutory term.
13. Also referred to as "branching off" by Radauer et al. (2015).
14. [http://dpma.de/english/utility\\_models/procedure/index.html](http://dpma.de/english/utility_models/procedure/index.html) Accessed on July, 13, 2015.
15. [http://dpma.de/english/utility\\_models/procedure/index.html](http://dpma.de/english/utility_models/procedure/index.html) Accessed on September 25, 2015.
16. Gebrauchsmustergesetz (GebrMG) (adapted on July 31, 2009) §19.
17. Question 13.1. (Formale Maßnahmen) in the MIP 2005: "Hat Ihr Unternehmen in den Jahren 2002-2004 eine der folgenden Schutzmaßnahmen für geistiges Eigentum genutzt?"
18. A four-point Likert scale (totally agree, agree, disagree, totally disagree).
19. [http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech\\_classification\\_of\\_manufacturing\\_industries](http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries) Accessed on September 16, 2015.
20. It is possible that a firm had patented an invention in the 1980s and that this patent was still used to protect the firm's IP in the period from 2002-2004.
21. Separate probit models would not take into account this correlation of unobserved determinants of patents and UMs and would therefore be a less efficient alternative. However, we also estimated separate probit models and obtained similar results.

22. The results of robustness checks are presented in the Appendix.
23. In the MIP2005 questionnaire, the firms were asked, “How many competitors has your firm in its main market?”: 0, 1-5, 6-15, 15-. We constructed dummy variables to control for the level of competition.

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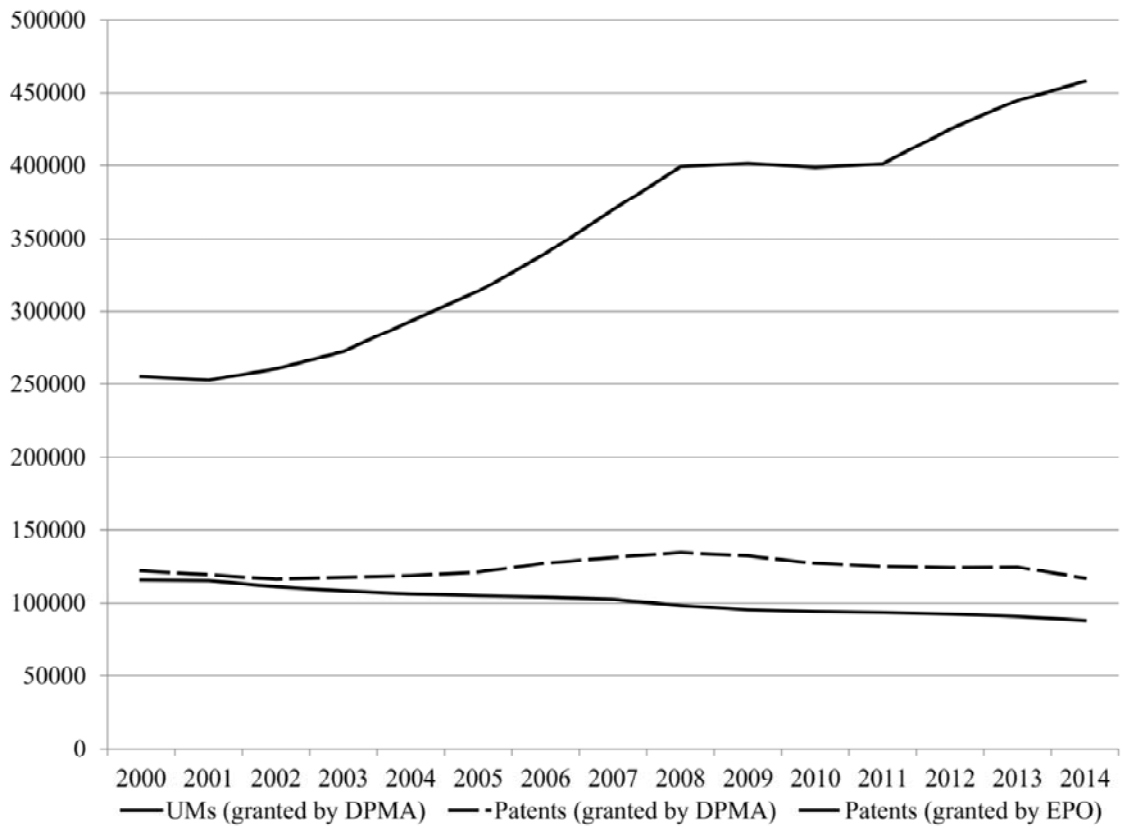
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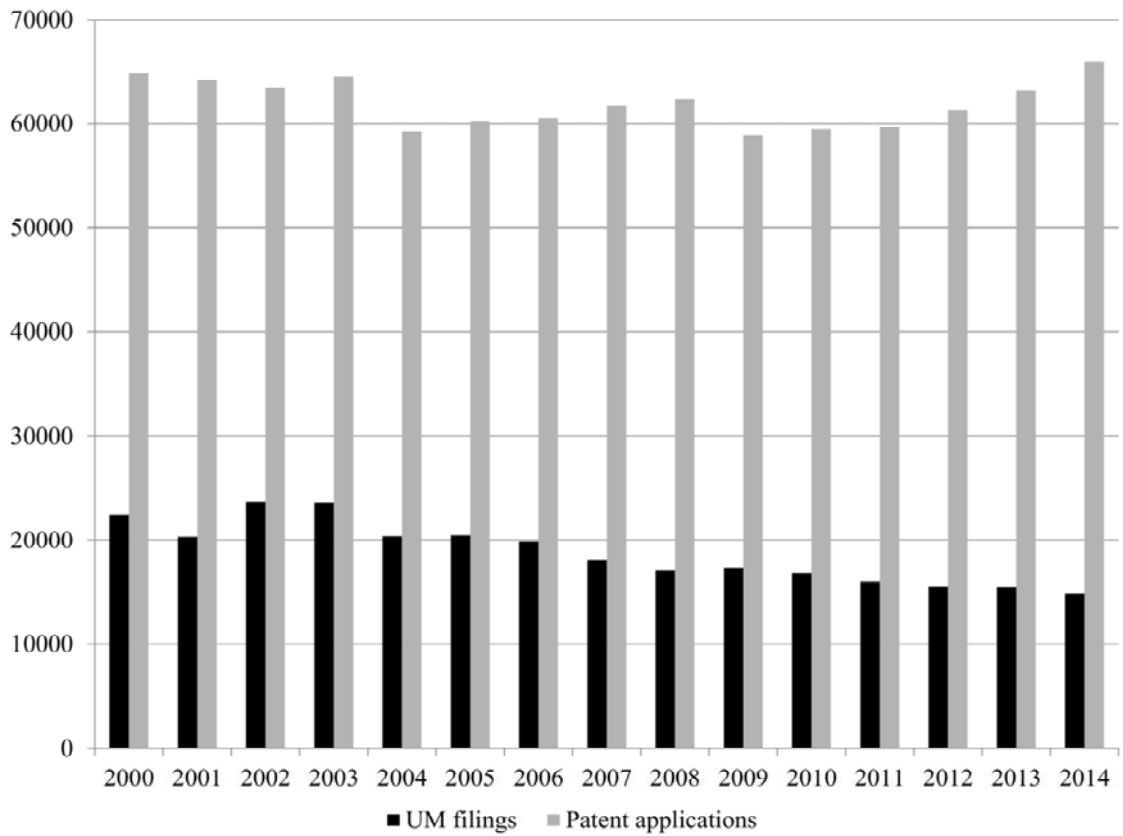
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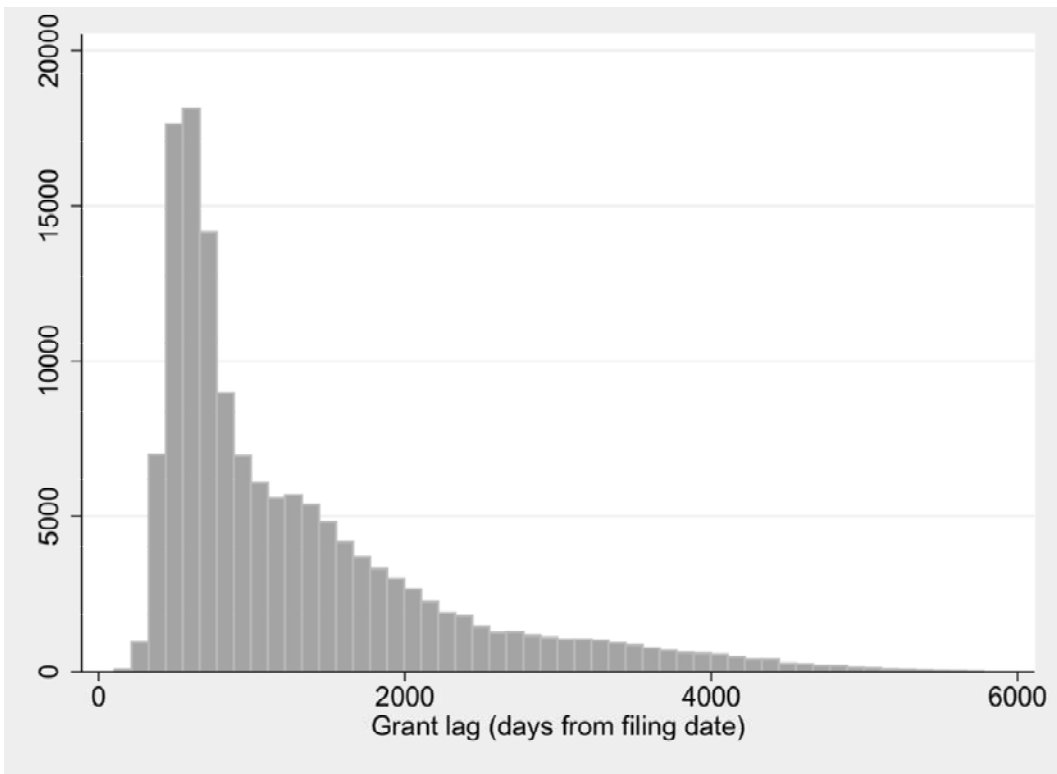
**Figure 1**



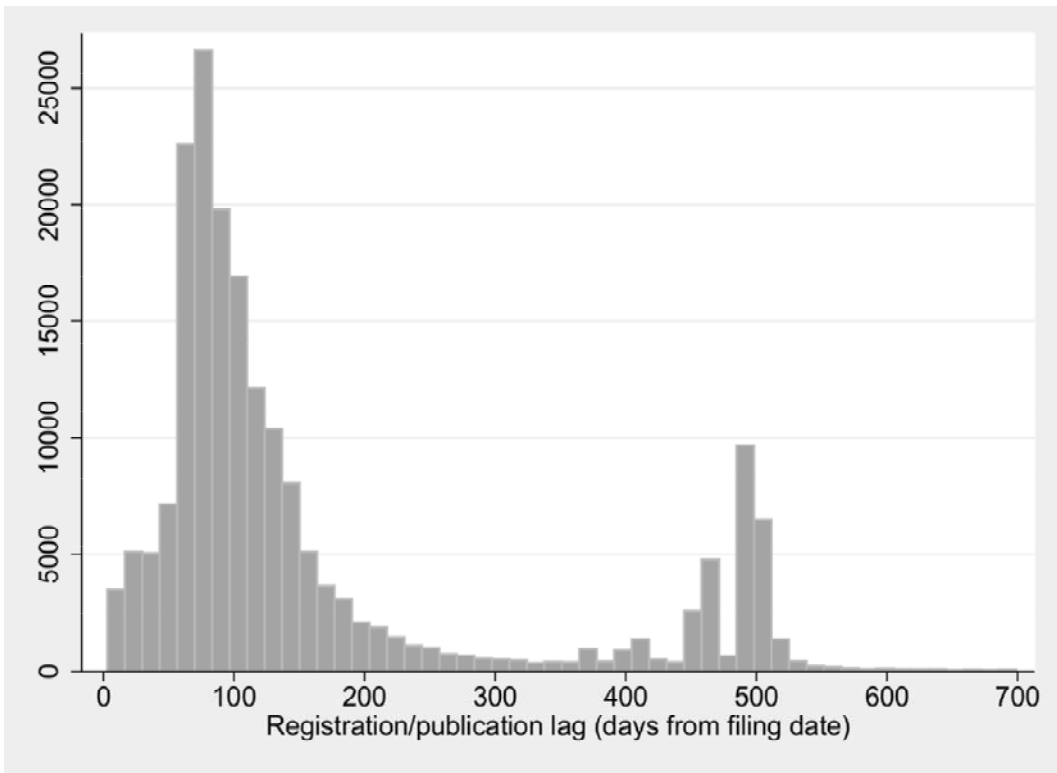
**Figure 2**



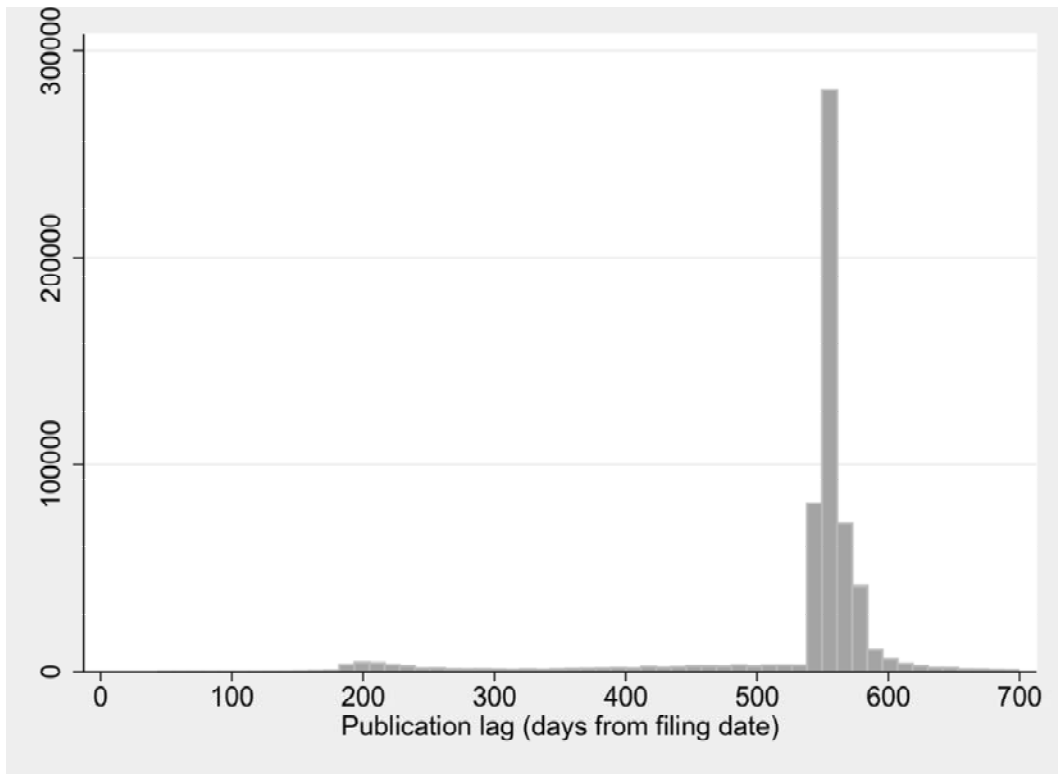
**Figure 3**



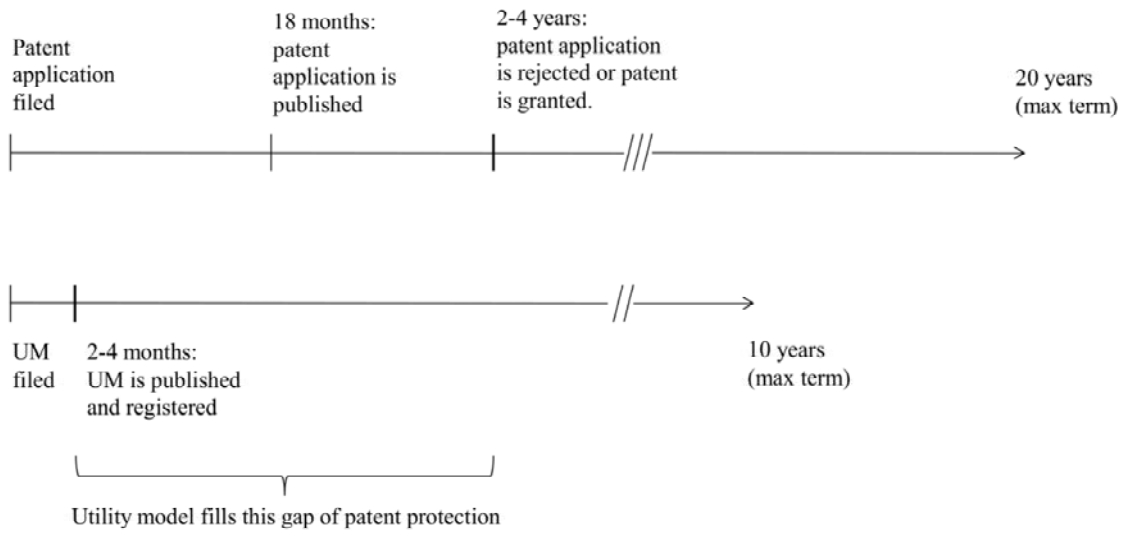
**Figure 4**



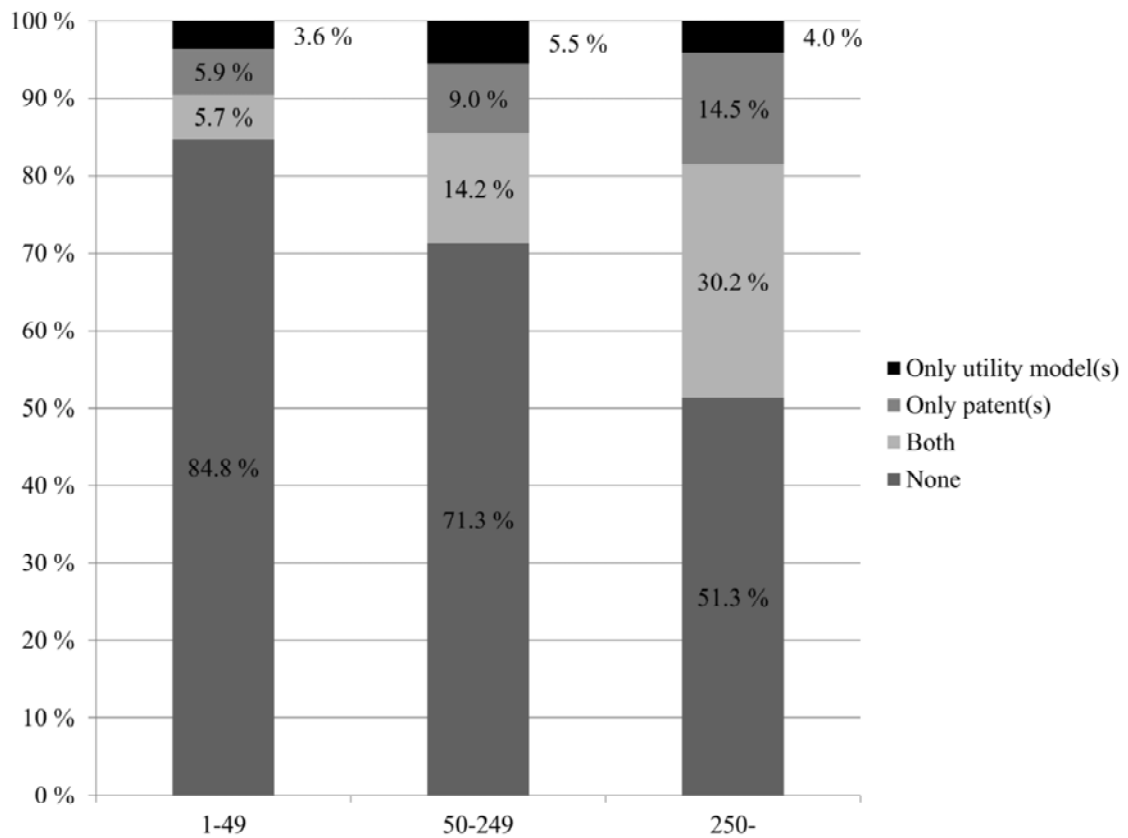
**Figure 5**



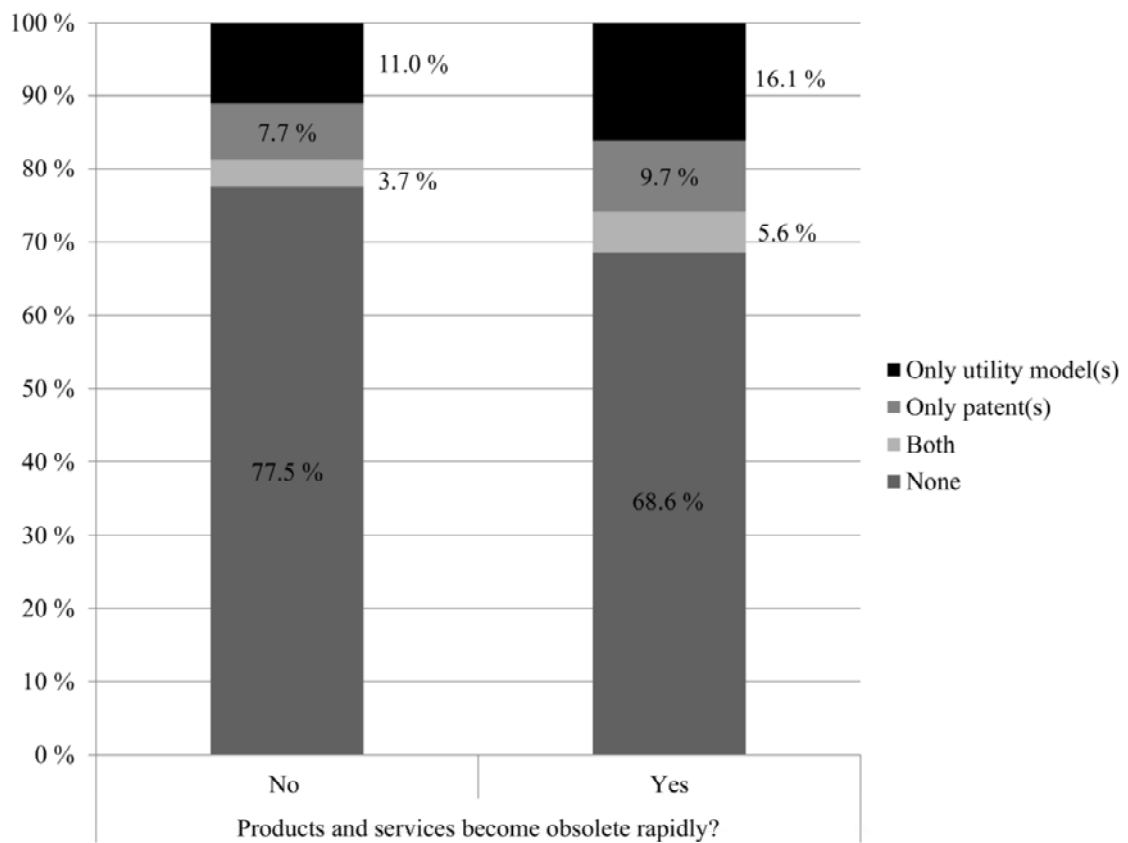
**Figure 6**



**Figure 7**



**Figure 8**





**Table 1**

	<b>Patent</b>	<b>Utility model</b>
Maximum term of protection	20 years	6-15 years
Inventive step requirement	Yes	Typically lower
Novelty requirement	Global	Global or local
Examination at the patent office	Yes	No*
Publication lag from filing	18 months	Some months
Grant lag	Years	Typically months
Process inventions	Yes	No

**Table 2**

	Observations	Mean	Sd.	Median	Min	Max
<b>Grant/registration lags 2000-2010</b>						
Grant lag of patents	125319	1364.91	970.44	1025	204	5776
Registration lag of utility models	156657	185.07	215.99	107	8	3710
<b>Publication lags 2000-2014</b>						
Patents	578598	540.01	105.50	554	44	5769
Utility models	194242	176.58	203.87	101	3	3553

**Table 3**

	The use of patents and utility models														
	No patents or utility models			Patents and utility models											
	N	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.	T total					
Employees	2265	174.92	1322.21	127	214.34	943.63	249	309.07	597.74	375	1899.66	11724.51	3016	402.10	4330.27
R&D per employee (€)	2265	3539.75	26101.05	127	14642.54	72091.04	249	30338.13	61359.98	375	14642.45	28630.01	3016	7600.22	34691.19
Export share	2265	0.089	0.192	127	0.214	0.248	249	0.354	0.282	375	0.338	0.282	3016	0.147	0.240
Group member dummy	2265	0.544	0.498	127	0.598	0.492	249	0.711	0.454	375	0.731	0.444	3016	0.583	0.493
Short life cycle dummy	2265	0.250	0.433	127	0.362	0.483	249	0.321	0.468	375	0.355	0.479	3016	0.274	0.446

**Table 4**

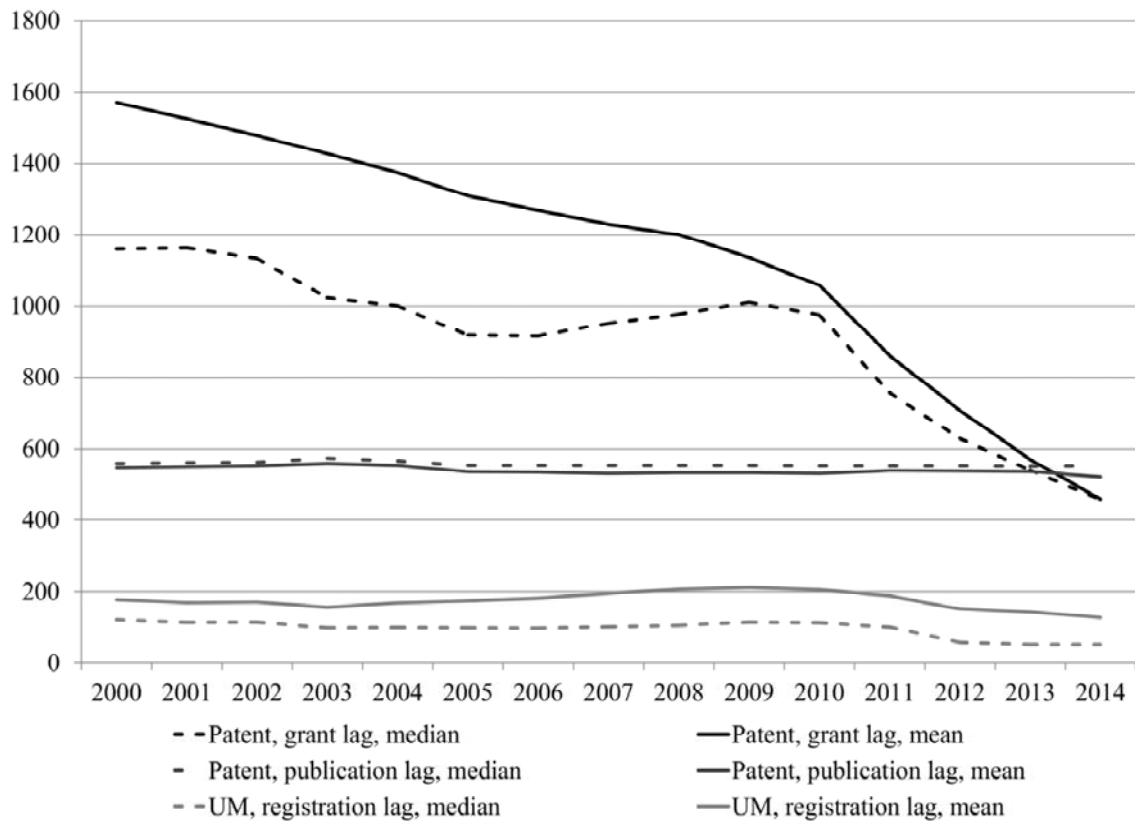
Model	Bivariate probit					
	Patent	UM	Patent=1, UM=1	Patent=1, UM=0	Patent=0, UM=1	Patent=0, UM=0
Dependent variable	Coeff.	Coeff.	M.E.	M.E.	M.E.	M.E.
Estimate	(1)	(2)	(3)	(4)	(5)	(6)
D(Short life cycle)	0.031 (0.070)	0.186*** (0.067)	0.015* (0.008)	-0.008 (0.008)	0.023*** (0.009)	-0.030* (0.016)
log(Employees)	0.198*** (0.021)	0.164*** (0.020)	0.024*** (0.002)	0.016*** (0.003)	0.008*** (0.002)	-0.048*** (0.005)
log(R&D per employee)	0.125*** (0.008)	0.078*** (0.008)	0.013*** (0.001)	0.012*** (0.001)	0.002** (0.001)	-0.027*** (0.002)
log(Export intensity)	1.482*** (0.172)	0.884*** (0.176)	0.155*** (0.022)	0.140*** (0.022)	0.018 (0.021)	-0.313*** (0.040)
D(Group member)	-0.010 (0.072)	-0.078 (0.067)	-0.006 (0.008)	0.004 (0.008)	-0.009 (0.008)	0.012 (0.016)
Constant	-2.199*** (0.136)	-2.120*** (0.136)				
Technology classes (7)	Yes					
$\rho$	0.767*** (0.024)					
Log-likelihood	-1869.07					
Observations	3016					

Table 5

Model	Bivariate ordered probit	
	Patent	UM
Dependent variable	Coeff.	Coeff.
Estimate	(1)	(2)
D(Short life cycle)	0.009 (0.067)	0.150** (0.065)
log(Employees)	0.184*** (0.019)	0.147*** (0.018)
log(R&D per employee)	0.130*** (0.008)	0.081*** (0.008)
log(Export intensity)	1.508*** (0.167)	0.928*** (0.172)
D(Group member)	0.009 (0.068)	-0.053 (0.065)
Technology classes (7)		Yes
Constant cut1	2.228 (0.129)	2.066 (0.125)
Constant cut2	2.376 (0.127)	2.212 (0.124)
Constant cut2	2.686 (0.131)	2.599 (0.130)
$\rho$	0.721*** (0.024)	
Log pseudolikelihood	-2818.01	
Observations	3004	

## Appendix

Figure A.1. Grant, registration, and publication lags



Note: Data source is the PATSTAT 2016 April edition. Priority patents and UMs filed at the German patent office 2000-2014 are reported. PCT applications are excluded. For UMs, the registration lag is the same as publication lag. Y-axis measures days from the filing date. Decreasing grant lag of patents is caused by truncation as pending patents are not taken into account when calculating medians and means.

Table A.1. The use of protection methods for the subsample of innovators, bivariate probit model

Model	Bivariate probit					
	Patent	UM	Patent=1, UM=1	Patent=1, UM=0	Patent=0, UM=1	Patent=0, UM=0
Dependent variable	Coeff.	Coeff.	M.E.	M.E.	M.E.	M.E.
Estimate	(1)	(2)	(3)	(4)	(5)	(6)
D(Short life cycle)	-0.019 (0.081)	0.186** (0.078)	0.021 (0.016)	-0.027* (0.015)	0.033** (0.013)	-0.027 (0.025)
log(Employees)	0.223*** (0.026)	0.188*** (0.024)	0.045*** (0.005)	0.024*** (0.005)	0.008** (0.004)	-0.077*** (0.008)
log(R&D per employee)	0.111*** (0.012)	0.053*** (0.010)	0.018*** (0.002)	0.017*** (0.002)	0.003* (0.002)	-0.032*** (0.003)
log(Export intensity)	1.545*** (0.207)	0.748*** (0.211)	0.246*** (0.040)	0.237*** (0.045)	-0.035 (0.033)	-0.449*** (0.066)
D(Group member)	-0.041 (0.088)	-0.107 (0.083)	-0.018 (0.017)	0.005 (0.017)	-0.013 (0.013)	0.026 (0.028)
Technology classes (7)	Yes					
Constant	-2.603*** (0.165)	-2.341*** (0.149)				
$\rho$	0.710*** (0.031)					
Log-likelihood	-1374.71					
Observations	1675					

Notes: The dependent variables are indicator variables for the use of patents and utility models. First two columns report the estimated coefficients for bivariate probit model. Columns 3-6 present the marginal effects for patent and utility model combinations. Heteroscedasticity robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table A.2. The importance of UMs and patents for the subsample of innovators, bivariate ordered probit model

Model	Bivariate ordered probit	
	Importance of patents	Importance of UMs
	Coeff (1)	Coeff (2)
D(Short life cycle)	-0.030 (0.076)	0.140* (0.075)
log(Employees)	0.201*** (0.023)	0.157*** (0.021)
log(R&D per employee)	0.113*** (0.012)	0.055*** (0.010)
log(Export intensity)	1.547*** (0.197)	0.785*** (0.201)
D(Group member)	-0.022 (0.083)	-0.061 (0.079)
Technology classes (7)		Yes
Constant cut1	2.094 (0.170)	1.788 (0.156)
Constant cut2	2.207 (0.170)	1.894 (0.155)
Constant cut2	2.532 (0.174)	2.306 (0.161)
$\rho$	0.681*** (0.030)	
Log pseudolikelihood	-2129.30	
Observations	1664	

Notes: The dependent variables are ordinal variables indicating the importance of patents and utility models as IP protection methods. 12 firms, which reported to use patents and/or utility models but did not answer the importance question, are omitted. Robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table A.3. The use of protection methods and additional controls, bivariate probit model

Model	Bivariate probit		Marginal effects after bivariate probit model			
	Patent	UM	Patent=1, UM=1	Patent=1, UM=0	Patent=0, UM=1	Patent=0, UM=0
Dependent variable	Coeff.	Coeff.	M.E.	M.E.	M.E.	M.E.
Estimate	(1)	(2)	(3)	(4)	(5)	(6)
D(Short life cycle)	0.039 (0.073)	0.193** (0.070)	0.017* (0.009)	-0.009 (0.009)	0.025*** (0.010)	-0.034 (0.018)
log(Employees)	0.215*** (0.023)	0.177*** (0.021)	0.028*** (0.003)	0.018*** (0.003)	0.009*** (0.003)	-0.055*** (0.005)
log(R&D per employee)	0.120*** (0.009)	0.072*** (0.008)	0.014*** (0.001)	0.012*** (0.001)	0.001 (0.001)	-0.027*** (0.002)
log(Export intensity)	1.429*** (0.180)	0.841*** (0.183)	0.161*** (0.024)	0.144*** (0.025)	0.014 (0.024)	-0.320*** (0.044)
D(Group member)	-0.010 (0.074)	-0.100 (0.070)	-0.008 (0.009)	0.006 (0.009)	-0.013 (0.009)	0.015 (0.017)
D(Financial constraint)	0.139** (0.067)	0.022 (0.066)	0.011 (0.008)	0.019** (0.009)	-0.007 (0.008)	-0.023 (0.016)
Competition categories						
0 competitors	-0.119 (0.209)	-0.187 (0.217)				
1-5 competitors	0.167 (0.097)	0.062 (0.090)				
6-15 competitors	0.040 (0.112)	0.041 (0.105)				
15- competitors	ref.	ref.				
Technology classes (7)		Yes				
Constant	-2.863*** (0.156)	-2.341*** (0.149)				
$\rho$	0.760*** (0.025)					
Log-likelihood	-1741.85					
Observations	2704					

Notes: The dependent variables are indicator variables for the use of patents and utility models. First two columns report the estimated coefficients for bivariate probit model. Columns 3-6 present the marginal effects for patent and utility model combinations. Financial constraint is a dummy variable, 1 if firm reported a financial constraint as an obstacle for innovation in 2004 and 0 otherwise. Competition categories are dummies for the number of competitors: 0, 1-5, 6-15, 15-. The reference group is more than 15 competitors. Heteroscedasticity robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .



Table A.4. The importance of UMs and patents and additional controls, bivariate ordered probit model

Model Dependent variable Estimate	Bivariate ordered probit	
	Importance of patents Coeff.	Importance of UMs Coeff.
	(1)	(2)
D(Short life cycle)	0.011 (0.069)	0.151** (0.067)
log(Employees)	0.199*** (0.020)	0.157*** (0.019)
log(R&D per employee)	0.126*** (0.008)	0.076*** (0.008)
log(Export intensity)	1.472*** (0.173)	0.882*** (0.177)
D(Group member)	0.012 (0.071)	-0.069 (0.067)
D(Financial constraint)	0.125** (0.063)	0.017 (0.063)
Competition categories		
0 competitors	-0.019 (0.221)	-0.177 (0.229)
1-5 competitors	0.118 (0.094)	0.049 (0.087)
6-15 competitors	0.017 (0.109)	0.047 (0.103)
15- competitors	ref.	ref.
Technology classes (7)		
Constant cut1	2.439 (0.239)	2.266 (0.243)
Constant cut2	2.589 (0.239)	2.411 (0.244)
Constant cut2	2.910 (0.241)	2.813 (0.246)
$\rho$	0.714*** (0.025)	
Log pseudolikelihood	-2664.54	
Observations	2692	

Notes: The dependent variables are ordinal variables indicating the importance of patents and utility models as IP protection methods. 12 firms, which reported to use patents and/or utility models but did not answer the importance question, are omitted. Financial constraint is a dummy variable, 1 if firm reported a financial constraint as an obstacle for innovation in 2004 and 0 otherwise. Competition categories are dummies for the number of competitors: 0, 1-5, 6-15, 15-. Heteroscedasticity robust standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .