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

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Abstract
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Abstract

Despite the wide use of two-tiered patent systems (patents and utility models), there is little empirical evidence about how often and what kind of firms use utility models 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 utility models. The functioning of the German utility model system is 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 systems; product life cycle; intellectual property strategy

JEL classification: 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 & Nelson, 1998; Kingston, 2001; Encaoua et al., 2006; Moser 2005). Moreover, the importance of the patent system for e.g. a country’s productivity growth may be conditional on the country’s level of development (Kim et al., 2012) and its institutions. It is thus unclear which kind of system of IPRs is desirable and how its design ought to vary across different institutional contexts. A necessary step in the search for an optimal IPR system and combination of innovation policy instruments is thus 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 TRIPS agreement introduced minimum standards for many forms of intellectual property (IP), rendering it the most comprehensive international agreement on intellectual property to date\(^1\). 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

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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). Since there are no international agreements on minimum standards of second tier patent systems, countries may design UM systems as they see fit.

UM systems in advanced economies are often justified by emphasizing their importance to small and medium-sized enterprises (SMEs) and individual inventors. The reason for this is that UM are argued to be 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). UM and second tier patent systems have therefore been claimed to foster minor inventions, which do not satisfy patentability requirements (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 missing entirely. For instance, Kim et al. (2012) did not find UM systems to be associated with economic growth in advanced economies.

Although both patents and UM 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. What determines a firm’s decision to opt for patents or utility models (or both), and hence, to choose between these appropriation mechanisms? While insightful, prior theoretical (Anton & Yao, 2004; Kultti et al., 2007; Hall et al., 2013) and empirical (Arundel, 2001; Hussinger, 2006; Hall et al., 2013, 2014; Heger & Zaby, 2013)

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2 UM are often considered as 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 utility models might be overstated because administrative cost are only a small part of total patenting costs: in practice patent attorneys are frequently hired to draft applications and their fees are much larger than administrative application costs. See also van Pottelsberghe & Francois (2008) and Königer (2009).
studies have mainly focused on the trade-off between patents and secrecy as IP protection methods. Our paper contributes to the much thinner literature on UMs (reviewed in the next section) by exploring the determinants of firms’ decisions to use patents and/or utility models and by identifying firm characteristics that are associated with the use and relative importance of patents and utility models. Inspired by Cao et al. (2014), we focus on the trade-off between utility models, which arguably is an appropriate protection method for firms with a need to protect their inventions quickly (“need for speed”), and patents, which are slower 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 utility models 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 utility model system is an inclusive institution by promoting protection of IP among resource constrained small firms but 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 utility models. This suggests that utility models do not serve only applicants with incremental inventions but also applicants in need for fast 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. In Europe the harmonization of IPR systems has been a top priority (see European Commission, 2011) but national utility model systems have been ranked low on the agenda since the European Union member
The paper is structured as follows: Section 2 reviews the related literature. The German utility model system is described in section 3. In section 4 we discuss the possible determinants of the use of patents and utility models 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 utility model 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 utility model systems vary significantly across countries, as they are not internationally regulated or harmonized. Second, the stated justification of utility model 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 registration process). Table 1 illustrates some dimensions along which patent and utility model protection typically differ.

TABLE 1 Comparison of patent and utility model protection

states suspended the proposal for a “community utility model” (European Commission, 1995) in March 2000 (European Commission, 2000). However, after the unitary patent system is in place and working, it is likely that more attention will be allocated to the harmonization of national utility model systems.
While utility model 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 utility models has been scarcer. In quantitative patent data analyses it is common to treat utility models as patents (e.g. Hu & Jefferson, 2009). Maskus & McDaniel (1999) found Japanese utility model system to have played an important role in the diffusion of technologies. They argue that the primary channels of diffusion were follow-up utility model applications for incremental inventions which built on prior technical knowledge embodied in patent applications. Beneito (2006) focuses on firm-level determinants of patent and utility model use in Spanish R&D intensive firms. She explicitly assumes patents and utility models to be measures of significant and incremental innovations respectively and found the number of patents to be associated with in-house R&D and utility models with contracted R&D. By using Korean data, Kim et al. (2012) show that utility models are positively associated with firm growth when firms are technologically lagging. Kim et al. argue that such firms may use minor innovations protected by utility models as a learning device and as “a stepping
stone for developing more patentable inventions later on” (p. 358). Thomä & Bizer (2013) investigate combinations of IP rights utilized by SMEs in Germany using CIS data. Although utility models are included in their analysis, Thomä & 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 utility models. This suggests that utility models 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 utility models can also be combined under certain conditions. This means that they are not necessarily mutually exclusive or substitutes (Guellec & 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 patents in the US. On the basis of Lemley et al. (2005), Atal & Bar (2014) construct a theoretical model highlighting the role of two-tiered patent systems as signaling (or screening) devices. According to Atal & 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” (low probability of validity) 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 patents system enables screening and self-selection, which diminishes this negative externality. Importantly, Atal & Bar 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” (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 & Nelson, 1998; Johnson & Popp, 2003; Denicolò & Franzoni, 2004; Guellec & van Pottelsberghe, 2007; Graham & 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 & Steinmueller, 1998). Utility models 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 utility model system, rendering it the oldest utility model system in the world, which is why it is often used as a reference for other countries (Kingston, 2001; Guellec & van Pottelsberghe, 2007). Initially, the aim of the German utility model 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 utility models 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 utility model can be extended for a maximum of ten years. Although the utility model is often referred to as a "petty patent" or “small patent”, in Germany the inventive step requirement has been the same for patents and utility models since 2006 (Björkwall, 2009; Grosse Ruse-Khan, 2013; Prud’homme, 2014; Radauer et al., 2015).

Recent statistics of utility models and patents in force in Germany (granted by the DPMA) show a slightly decreasing trend (as depicted in Figure 1). Moreover, figure 2 indicates that the number of utility model registrations is declining faster than the number of national patent applications. Between 2000 and 2014 utility model filings decreased by more than a 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 granted European Patent Office (EPO) patents in Germany has steadily been increasing: from 255,303 in 2000 to 458,042 in 2014 (79.4%). Part of the decrease in utility model filings could be explained by the above mentioned decision of the German Supreme court to apply the same inventive step requirement for utility models as for patents.

FIGURE 1. Patents and utility models in force in Germany 2000-2014
Source: DPMA annual reports 2006-2014, available at:

The German utility model system has been designed especially considering the needs of SMEs (Suthersanen, 2006; Königer, 2009; Grosse Ruse-Khan, 2013). The procedure to register a utility model at the German patent office is simpler and somewhat cheaper than the procedure to apply for a patent. This is reflected by statements of 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)\(^4\)

“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 & Hernandez patent attorneys)5

Additionally, Radauer et al. (2015, pp. 32-33) report six beneficial features of German utility models that stand out in a 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. to comply 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 utility model adds flexibility to the German patent system.

3.2 The process of registering a utility model in Germany6

Examination and grant 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 utility model is registered on average within 2-4 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 utility models as “the fast IP rights”7.

5 http://www.wh-ip.de/patentanwalt/gebrauchsmuster_anmelden.html#allgemeine_informationen
6 This section is mainly based on information retrieved from the DPMA’s webpage.
Table 2 reports descriptive statistics for German patents and utility models concerning pendency times and publication lags. The mean grant lag of patents and the registration lag of utility models are affected by right-skewed lag distributions as the median lags are considerably shorter than the respective means. Between 2000 and 2010 the median grant lag for German patents was 2.8 years while for utility models the median registration lag was approximately three months.

TABLE 2 Publication, registration and grant lags of patents and utility models

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>Mean</th>
<th>Sd.</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grant/registration lags 2000-2010</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Grant lag of patents</td>
<td>125319</td>
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<td>970.44</td>
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<tr>
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<td>185.07</td>
<td>215.99</td>
<td>107</td>
<td>8</td>
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<tr>
<td><strong>Publication lags 2000-2014</strong></td>
<td></td>
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<tr>
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<td>5769</td>
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<tr>
<td>Utility models</td>
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<td>176.58</td>
<td>203.87</td>
<td>101</td>
<td>3</td>
<td>3553</td>
</tr>
</tbody>
</table>

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

FIGURE 3 Grant lag distribution of German patents 2000-2010

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8 The source of data is PATSTAT (April 2016 edition). Populations consist of German priority patent and utility model 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.
Note: Data source is PATSTAT 2016 April edition. All priority patents filed at the German patent office 2000-2010. PCT filings are excluded.

FIGURE 4 Registration/publication lag distribution of German utility models 2000-2014
Note: The data are based on the PATSTAT 2016 April edition and cover all priority utility models filed at the German patent office 2000-2010. Outliers, utility models 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\textsuperscript{10}. Figure 5 depicts the publication lags of patents. The 18 months secrecy period does not apply to utility models. Instead, if a utility model application does not have any defects, or if the defects have been remedied, the utility model is entered in the DPMA register and

hence its contents become public knowledge\textsuperscript{11}. For utility models the publication date is the same as the registration date.

FIGURE 5 Publication lag distribution of German patents 2000-2014

![Publication lag distribution of German patents 2000-2014](image)

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

In Germany, a utility model 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

\textsuperscript{11} Upon request publication of the utility model can be postponed for up to 15 months beginning from the filing date but of course protection commences with publication of the utility model. See §§ 8 Abs. 1 GebrMG, 49 Abs. 2 PatG. See also: \url{http://www.wh-ip.com/germany/german_utility_model.html} Accessed on 13 July 2015.  
other hand cannot be enforced when they are pending. Thus, while utility models can only be in force for 10 years the difference in potential effective life (from grant to expiration) to patents is decreased by the fast grant\textsuperscript{12}. Nonetheless, a utility model is an unexamined IP right as it lacks substantive examination: patent examiners at the DPMA do not examine novelty, inventive step and industrial applicability of the invention before its registration. Therefore, inventors should conduct thorough searches to make sure that the application actually meets the requirements that apply to effective IP rights. Unexamined IP rights comprise inherent legal uncertainty (Suthersanen, 2006; König, 2009; Prud’homme, 2014; Radauer et al., 2015). Weak patents may be socially costly as they can create a danger of patent hold-up, lead to costly litigations and induce a vicious cycle of defensive patenting (Farrell & Shapiro, 2009; Atal & Bar, 2014).

A peculiarity of the German utility model system is the novelty grace period: If an inventor applies for a utility model registration within six months from the publication of her invention, utility model 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 & Scellato, 2010). This means that in most European patent systems publication of an invention destroys its novelty and a patent cannot be granted anymore (Franzoni & Scellato, 2010). In Germany the grace period of utility models enables inventors to protect their disclosed inventions with utility models.

In Germany there is a possibility for double granting i.e. an applicant can protect the same invention with both a patent and a utility model (Guellec & van Pottelsberghe, 2007; Guellec & van Pottelsberghe, 2007; Harhoff et al., 2015). Guellec & 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.

\textsuperscript{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 & van Pottelsberghe, 2007; Harhoff et al., 2015).
Prud’homme, 2014; Radauer et al., 2015). Splitting-off\textsuperscript{13} a utility model provides protection in the period between patent application and grant, when no or only limited protection is available\textsuperscript{14}. By making a respective splitting-off declaration, an applicant may obtain an independent utility model application, for which it is possible to claim the priority date from the patent application. Upon registration of the split-off utility model, 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 utility model protection it is possible to extend patent protection from the front end. Figure 3 provides an overview of patenting and utility model processes in Germany and illustrates the gap in the time dimension of patent protection which the utility model protection is filling.

\textbf{FIGURE 6} Patenting and utility model registration processes in Germany

Although German utility models (and patents) are presumed valid until proven otherwise, the bifurcation principle (infringement and validity of a patent are decided

\textsuperscript{13} Also referred to as “branching off” by Radauer et al. (2015).

\textsuperscript{14} \url{http://dpma.de/english/utility_models/procedure/index.html}, Accessed on 13 July 2015.
independently by different courts) does not apply to utility models (Cremers et al., 2013; Cremers et al., 2014). In utility model disputes the defendant is allowed to raise invalidity defense (Cremers et al., 2013), whereas this is not possible in patent suits. Then cancellation proceedings will clarify whether the utility model is actually valid, i.e., that the invention is new and involves an inventive step15. The utility model infringement suit shall be suspended until the resolution of cancellation proceedings16.

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 utility models 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, 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 utility models should be similar to those of patents, as utility models are also a protection method for technical inventions. The two main differences between the German patents and utility models relate to the

16 Gebrauchsmustergesetz (GebrMG) (adapted on 31 July 2009) §19.
speed of protection and to the threshold of obtaining protection. The benefits and costs of using patents and UMs are expected to vary with firm characteristics. Next, we develop hypotheses concerning the choices between utility models 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 IPRs. 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’) (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 & Karnani, 1987; Byma & 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 utility models 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 (Allison et al., 2004; Harhoff et al., 2003). Such inventions can be incremental or more radical (significant). Moreover, larger firms probably 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 utility models for less valuable inventions (Beneito, 2006). In Germany it is possible that inventions are protected with both a patent and a utility model, since the legislation allows double granting (Guellec & 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 utility models.

**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 utility models can be granted as fast as in 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 1989-1996. Table 2 and Figures 2 and 3 in section 3.2 depict the difference in patent grant lag and utility model registration lag distributions for the population of German priority filings 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 utility models among 47 respondents. Furthermore, Radauer et al. (2015) report the most useful feature of utility models, which stood out in interviews of IP professionals and utility model users: “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 utility models lies in the time dimension of protection: patents offer slower but longer protection whereas utility models 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 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 slower patents (Cohen et al., 2000; Arundel, 2001; Byma & Leiponen, 2009; Thomä & 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 utility models and also rate a higher importance to utility models relative to patents\(^\text{17}\).

Hypothesis 2a:

*Firms reporting to have short life cycles of products and services are more likely to use utility models than other firms.*
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 utility models. 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 and therefore it would be rational to patent and protect inventions against competitors. If this reasoning is correct, then the association between short life cycles and the choice of utility models 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 questions and a few additional country-specific questions. Previously Thomà & Bizer (2013) utilized these data to study the innovation protection mechanisms of small German firms. They also provide a detailed description on how the MIP2005 was collected. The questions in MIP2005 refer to the three year period from 2002 to 2004. Thus, the survey considers the period before the German Supreme Court’s decision in 2006 to abolish the inventive step difference between patents and utility models. As shown in figure 1, it seems that this legal change led to a slight but not dramatic decrease in the level of utility model 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 which firms used to protect their intellectual property.

EXTEND!

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 MIP2005 ask, whether the respondent firm had used the listed formal protection methods (patent, utility model, design right, trademark and copyright) to protect intellectual property during past three years\(^\text{18}\). We construct binary variables to indicate the use of patents (P) and utility models (UM):

\[
\text{Use}_{i}^{j} = \begin{cases} 
1, & \text{if firm } i \text{ used protection method } j \text{ to protect IP 2002} - 2004 \\
0, & \text{otherwise}
\end{cases}
\]

where \( j \in \{P, UM\} \).

Conditional on using a specific intellectual property 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 make the assumption 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:

\[
\text{Imp}_{i}^{j} = \begin{cases} 
0, & \text{if } \text{Use}_{i}^{j} = 0 \\
1, & \text{if firm } i \text{ reports } j \text{ to be of low importance} \\
2, & \text{if firm } i \text{ reports } j \text{ to be of medium importance} \\
3, & \text{if firm } i \text{ reports } j \text{ to be of high importance}
\end{cases}
\]

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(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\(^\textsuperscript{19}\) that in its main market “products/services mature rapidly”, and is 0 otherwise (cf. Thomä & Bizer, 2013). We acknowledge that product and service life cycles differ across industries and that in the survey 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 Hypothesis 2a and 2b.

5.2.3 Control variables

We control for the following firm characteristics. Firms’ research and development investments are controlled for with the total R&D expenditure divided by full time 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 & 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 utility model systems (Kim et al., 2012). Group membership indicates whether a firm is a part of a larger group

\(^{19}\text{A four point Likert scale (totally agree, agree, disagree, totally disagree).}\)
of firms. Firms that are part of a larger group, i.e. a corporate, 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 & 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)\textsuperscript{20}. 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 utility models as follows. First, we examine which firm characteristics are associated with the use of patents and utility models by estimating a bivariate probit model (Greene 2012, pp.778-781). The bivariate probit model is appropriate for modeling joint determination of patent and utility model use, as they are presumably interrelated.

\[
\text{Use}_{i}^{*j} = \alpha^{j} + \beta_{1}^{j} \log(\text{Employees}_{i}) + \beta_{2}^{j} D(\text{Short life cycle}_{i}) + \delta^{j} \mathbf{x}_{i} + \theta_{k} + \epsilon_{i}^{j},
\]

\[
\text{Use}_{i}^{j} = 1 \text{ if } \text{Use}_{i}^{*j} > 1, 0 \text{ otherwise}
\]

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 disturbance correlation between the two equations i.e. the unobservables affecting the concurrent choice of patent and utility model 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 utility models by estimating a bivariate ordered probit model which is a direct extension of a univariate ordered probit model (Greene & Hensher, 2010). The model is similar to the presented bivariate probit model accounting for the fact that the dependent variables are ordinal variables \( \text{Imp}_j^i \), where \( j \in \{ P, UM \} \).

We are not claiming any causal relationships but 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 utilizing any IP protection method (during past three years i.e. 2002-2004). The firms that have been innovative in the past may have chosen or not to protect their inventions with patents or utility models or both\(^{21}\). Therefore, we did not want to narrow our baseline sample and estimations to only

\[
\left( \begin{array}{c}
\varepsilon^P_i \\
\varepsilon^UM_i
\end{array} \right) \mid \log(\text{Employees}_i), D(\text{Short life cycle}_i), x_i \sim N\left( \begin{array}{c}
0 \\
0
\end{array} \right), \begin{pmatrix}
1 & \rho \\
\rho & 1
\end{pmatrix}
\]

\(^{21}\) It is possible that a firm had patented an invention in the 1980s and that this patent was still used to protect firm’s IP in 2002-2004.
recently innovative firms (i.e. firms that introduced innovation 2002-2004) or to R&D active firms (firms with R&D investments in 2002-2004).

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

6 Empirical analysis

6.1 Descriptive analysis

Table 3 presents the descriptive statistics by the categories of patent and utility model users. 75% of our sample firms (2,265/3,016) neither used patents nor utility models to protect 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 to have short product and service life cycles. Only a minority (127/3,016=4.2%) of the sample firms use utility models only. These firms are smaller on average, invest less R&D per employee and have a lower export share of turnover than patenting firms.

In line with the need for speed hypothesis (2a) utility model users (36.2%) frequently report to have short life cycles of products and services although the differences to only patent users (32.1%) and patent and utility model 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 have the most employees on average. Firms using only patents have by far the largest mean R&D expenditures.

TABLE 3 Descriptive statistics
<table>
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<th></th>
<th>No patents or utility models</th>
<th>Only utility models</th>
<th>Only patents</th>
<th>Patents and utility models</th>
<th>Total</th>
</tr>
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<td>s.d.</td>
<td>N</td>
<td>Mean</td>
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<td>214.34</td>
</tr>
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<td>14642.54</td>
</tr>
<tr>
<td>Export share</td>
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<td>0.192</td>
<td>127</td>
<td>0.214</td>
</tr>
<tr>
<td>Group member dummy</td>
<td>2265</td>
<td>0.544</td>
<td>0.498</td>
<td>127</td>
<td>0.598</td>
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<td>Short life cycle dummy</td>
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<td>0.250</td>
<td>0.433</td>
<td>127</td>
<td>0.362</td>
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</tbody>
</table>
Figure 4 illustrates how the use of patents and utility models is associated with firm size categories measured by the number of employees. Firms are classified into three categories: firms with 1-49 employees, 50-249 employees and more than 250 employees. The majority of sample firms does 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 utility models is the largest among medium sized (50-250 full time equivalent employees) enterprises (5.5%). The small proportions of firms using only utility models in all size categories indicates that utility model protection is rather a supplement protection method for patenting firms 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 5 shows that those firms that have short life cycles of products or services are more active users of patents and utility models. Among firms which have short life cycles of products and services 16.1% use utility models to protect intellectual capital, whereas among firms which did not report to have short life cycles of products or services, 11% have used utility models. This is consistent with hypotheses 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 biprobit model to analyze the determinants of concurrent patent and utility model utilization. Table 4 reports the estimated coefficients (columns 1-2) and the mean marginal effects (columns 3-6).

TABLE 4 The use of protection methods, bivariate probit model
Regarding the combined use of patents and utility models, 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 & Leiponen, 2009; Hall et al., 2013; Thomä & Bizer, 2013). Firm size is also positively associated with the likelihood to use only patents (column 4) and only utility models (column 5) but the estimated marginal effect is the highest in 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 utility models or both patents and utility models. In line with our expectations the association is higher between short life cycles and the use of only utility models, an increase of 2.3 percentage points (column 5), than between short life cycles and the use of patents and utility models, an increase of 1.5 percentage points (column 3).

A statistically significant positive $\rho$, i.e. the correlation of error terms, indicates that the use of patents and utility models is not independent of each other, conditional on the included covariates\textsuperscript{22}. Furthermore, a positive $\rho$ is in line with the view that patents and utility models 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 utility models are appropriate protection methods for incremental improvements (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 models is in particular driven by firms that use both patents and utility models rather than by firms that use only utility models, since the estimated marginal effect for the former is more than 6 times larger.

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.

\textsuperscript{22} 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.
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 utility models
highlights the importance of the utility model 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
utility models. Table 5 shows the results of the bivariate ordered probit estimation.
Generally, the estimates corroborate our findings about the use of patents and utility
models presented in Table 4. The need for speed Hypothesis 2b gets support as we find
short life cycles of products and services to be associated with the importance of utility
models but not with the importance of patents. Again the statistically significant positive $\rho$
suggests that there exists disturbance correlation between the equations i.e. the reported
importance of patents and utility models are related. 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
utility models. Thus, the use and importance of protection methods are closely linked as
expected.

TABLE 5 The stated importance of utility models and patents, bivariate ordered probit model
6.2.2 Robustness checks

First, various prior studies which have utilized Community Innovation Survey data have focused on subsamples of “recent innovators” (e.g. Hussinger, 2006, Thomä & Bizer, 2013, Hall et al., 2013). Hence, we re-estimated the use of protection method models (Table 4) for the subsample of innovating firms (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

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23 The results of robustness checks are presented in the appendix.
find firm size to be positively associated with the use of patents and utility models 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 utility models. The estimated marginal effects provide weak support that having a short life cycle of products and services is negatively associated with the use of only patents. In the case of the importance of patents and utility models, when we restrict the sample to innovators, we still find firm size to be positively associated with the use of patents and utility models. 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 utility modes 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 utility models in convincing investors (especially international investor which may not be equally familiar with utility model protection) and acquiring financial resources (Mann & Sager, 2007; Hoenen et al., 2014; Hoenig & Henkel, 2015). We also control for the level of competition in the firm’s main market24. The association between competition and the use of patents and utility models is unclear. On the one hand stronger competition may induce firms to “escape competition” by innovating (Aghion et al., 2005) and by protecting their intellectual property with 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

24 In 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.
on financial constraint and competition: firm size remains significantly positively associated with the use of and importance of patents and utility models. Short life cycle of products and services is also found to be positively associated with the use and importance of utility models but not with the use and importance of patents. Hypothesis 2 concerning the positive significant association between short product life cycle and the likelihood to use (only) utility models gets thus 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 utility models (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 utility models (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 utility models in acquiring external finance, as firms signal the quality of their invention with patents (Mann & Sager, 2007; Hoenen et al., 2014; Atal & Bar, 2014; Hoenig & 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” utility models instead of “expensive” patents.

Although none of the estimated coefficients on competition categories is statistically significant in Tables A.3 and A.4, the signs suggests a pattern that having zero competitors is associated with lower likelihood to use patents and utility models than having more
than 15 competitors (the reference group in estimations) whereas having 1-15 competitors is associated with higher likelihood to use patents and utility models. This is consistent with the “escape competition effect” and also 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 utility models (Hussinger, 2006; Hall et al., 2013; Heger & Zaby, 2013). In reality patent and utility model 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 a different length of life cycles. Thus, when a firm has several product lines and services the stated use and importance of intellectual property 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 utility models 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 very coarse proxy and is subjectively assessed by survey respondents. It is likely that this leads to attenuation bias i.e. the estimated coefficient on 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 utility models, which gives them competitive advantage and helps them grow. Thus, the association between firm size and the use of patents and
utility models is an endogenous process. As a consequence 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 utility models 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 utility model filings indicating that the lower inventive step requirement has not been the dominant motive to file utility models. Moreover, Figure A.1 in the appendix shows that the registration lags of German utility models 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 utility models instead of protection for minor inventions. However, an important topic for further research is to analyze how the use of German utility models 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 utility models among German firms. The results suggest that larger firms tend to take advantage of both patent and utility model 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 utility model system as “fast IP right”, we find short life cycles of products and services to be associated with the use and stated importance of utility models.

Our study is related to the ongoing process of harmonization of IPR systems within the European single market (see European Commission, 2011). Obviously national IPR systems and their differences increase transaction costs. Thus, it is likely that for many inventors and SMEs the patent system remains still 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 awareness of utility models as alternative protection mechanisms and concurrently avoid an IPR environment that is excessively complex for SMEs and individual inventors.

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 utility models is to study patenting behavior with patent and utility model data (e.g. PATSTAT) which is linked to data on applicant characteristics. As large firms seem to be active users of the utility model system, an important topic for future research is how the utility model system affects industry dynamics and competition between large incumbents and smaller entrants. Future studies could also investigate the underlying strategic motives to use utility models and how these motives vary across countries and industries.
REFERENCES


Suthersanen, U. 2006. Utility models and innovation in developing countries. The International Centre for Trade and Sustainable Development Issue Paper 13, UNCTAD. Available at:


APPENDIX

FIGURE A.1 Grant, registration and publication lags

Note: Data source is PATSTAT 2016 April edition. Priority patents and utility models filed at the German patent office 2000-2014. PCT applications are excluded. For utility models 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.
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<td>(2)</td>
<td>(3)</td>
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<td>(6)</td>
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<td>0.021</td>
<td>-0.027*</td>
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Note: 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 utility models and patents for the sub-sample of innovators, bivariate ordered probit model

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<tr>
<td>Constant cut2</td>
<td>2.532</td>
</tr>
<tr>
<td></td>
<td>(0.174)</td>
</tr>
<tr>
<td>ρ</td>
<td>0.681*** (0.030)</td>
</tr>
<tr>
<td>Log pseudolikelihood</td>
<td>-2129.30</td>
</tr>
<tr>
<td>Observations</td>
<td>1664</td>
</tr>
</tbody>
</table>

Note: 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

<table>
<thead>
<tr>
<th>Model</th>
<th>Bivariate probit</th>
<th>Marginal effects after bivariate probit model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patent</td>
<td>UM</td>
</tr>
<tr>
<td>Dependent variable Estimate</td>
<td>Coeff.</td>
<td>Coeff.</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>D(Short life cycle)</td>
<td>0.039***</td>
<td>0.193**</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
<td>(0.070)</td>
</tr>
<tr>
<td>log(Employees)</td>
<td>0.215***</td>
<td>0.177***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>log(R&amp;D per employee)</td>
<td>0.120***</td>
<td>0.072***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>log(Export intensity)</td>
<td>1.429***</td>
<td>0.841***</td>
</tr>
<tr>
<td></td>
<td>(0.180)</td>
<td>(0.183)</td>
</tr>
<tr>
<td>D(Group member)</td>
<td>-0.010</td>
<td>-0.100</td>
</tr>
<tr>
<td></td>
<td>(0.074)</td>
<td>(0.070)</td>
</tr>
<tr>
<td>D(Financial constraint)</td>
<td>0.139***</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>(0.067)</td>
<td>(0.066)</td>
</tr>
<tr>
<td>Competition categories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 competitors</td>
<td>-0.119</td>
<td>-0.187</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.217)</td>
</tr>
<tr>
<td>1-5 competitors</td>
<td>0.167</td>
<td>0.062</td>
</tr>
<tr>
<td></td>
<td>(0.097)</td>
<td>(0.090)</td>
</tr>
<tr>
<td>6-15 competitors</td>
<td>0.040</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>(0.112)</td>
<td>(0.105)</td>
</tr>
<tr>
<td>15-competitors</td>
<td>ref.</td>
<td>ref.</td>
</tr>
<tr>
<td>Technology classes(7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-2.863***</td>
<td>-2.341***</td>
</tr>
<tr>
<td></td>
<td>(0.156)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>( \rho )</td>
<td>0.760***</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-1741.85</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>2704</td>
<td></td>
</tr>
</tbody>
</table>

Note: 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. Heteroskedasticity robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
TABLE A.4 The importance of utility models and patents and additional controls, bivariate ordered probit model

<table>
<thead>
<tr>
<th>Model</th>
<th>Bivariate ordered probit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Importance of patents</td>
</tr>
<tr>
<td></td>
<td>Coeff. (1)</td>
</tr>
<tr>
<td>D(Short life cycle)</td>
<td>0.011 (0.069)</td>
</tr>
<tr>
<td>log(Employees)</td>
<td>0.199*** (0.020)</td>
</tr>
<tr>
<td>log(R&amp;D per employee)</td>
<td>0.126*** (0.008)</td>
</tr>
<tr>
<td>log(Export intensity)</td>
<td>1.472*** (0.173)</td>
</tr>
<tr>
<td>D(Group member)</td>
<td>0.012 (0.071)</td>
</tr>
<tr>
<td>D(Financial constraint)</td>
<td>0.125** (0.063)</td>
</tr>
<tr>
<td>Competition categories</td>
<td></td>
</tr>
<tr>
<td>0 competitors</td>
<td>-0.019 (0.221)</td>
</tr>
<tr>
<td>1-5 competitors</td>
<td>0.118 (0.094)</td>
</tr>
<tr>
<td>6-15 competitors</td>
<td>0.017 (0.109)</td>
</tr>
<tr>
<td>15+-competitors</td>
<td>ref.</td>
</tr>
<tr>
<td>Technology classes (7)</td>
<td></td>
</tr>
<tr>
<td>Constant cut1</td>
<td>2.439 (0.239)</td>
</tr>
<tr>
<td>Constant cut2</td>
<td>2.589 (0.239)</td>
</tr>
<tr>
<td>Constant cut3</td>
<td>2.910 (0.241)</td>
</tr>
<tr>
<td>(\rho)</td>
<td>0.714*** (0.025)</td>
</tr>
<tr>
<td>Log pseudolikelihood</td>
<td>-2664.54</td>
</tr>
<tr>
<td>Observations</td>
<td>2692</td>
</tr>
</tbody>
</table>

Note: 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.