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Seeing One's Hopes Dashed? Empirical Evidence on the Impact of the Research Use Exemption on the Propensity to Patent

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Abstract

The research use of patented knowledge is exempted in almost all countries issuing patents. However, its definition may create some uncertainties depending on whether the research exemption is statutory or is examined on a case by case basis. The research exemption may have effects on the research efforts of follow-up inventors and on the patenting behavior of successful inventors. While literature shows that the research exemption has a positive effect on the level of follow-up R&D activities, its impact on the propensity to patent is less analyzed. This paper shows evidence on how the propensity to patent is linked to the firms' belief about the implemented research exemption using a unique data set on German firms which focuses on the level of an innovation project. We find that the research use exemption has

a positive impact on the propensity to patent.

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Preliminary Version – Please do not quote

Abstract

The research use of patented knowledge is exempted in almost all countries issuing patents. However, its definition may create some uncertainties depending on whether the research exemption is statutory or is examined on a case by case basis. The research exemption may have effects on the research efforts of follow-up inventors and on the patenting behavior of successful inventors. While literature shows that the research exemption has a positive effect on the level of follow-up R&D activities, its impact on the propensity to patent is less analyzed. This paper shows evidence on how the propensity to patent is linked to the firms' belief about the implemented research exemption using a unique data set on German firms which focuses on the level of an innovation project. We find that the research use exemption has a positive impact on the propensity to patent.

Keywords: research use exemption, patenting decision, reverse engineering, technological lead.

JEL Classifications: O31, O34, C21

1 Introduction

This paper wants to contribute to the discussion why firms decide to patent the results of their R&D process. We add a facet of patent law to the discussion which has been broadly neglected by the literature. We investigate the impact of a research use exemption on the firms' propensity to patent. The research use exemption allows for the legal use of patented knowledge for research purposes. Hence, the input of patented knowledge into another firm's or institution's research process does not constitute an infringing action.

Research use exemptions exist in almost all countries issuing patents whereas its extent mostly depends on the national system of jurisdiction. For the U.S., it can be traced back to the decision in the case *Whittemore v. Cutter* in the year 1813* in which it is stated that it would have been the intention of legislature to exempt actions of the ones "who constructed such a machine merely for philosophical experiments, or for the purpose of ascertaining the sufficiency of the machine to produce its described effect". A statutory research use exemption for generic drugs was introduced after the *Roche v. Bolar* decision †. The Patent Term Restoration and Drug Price Competition Act, also called Hatch-Waxman Act, introduced a "safe harbor provision" for generic drug companies during clinical trials by implementing 33 U.S.C. § 271 (e) (1): "It shall not be an act of infringement to make, use, offer to sell or sell within the United States or import into the United States a patented invention ... solely for uses reasonably related to the development and submission of information under a Federal law which regulates the manufacture, use, or sale of drugs or veterinary biological products". This allows generic drug producers to enter the market at the time of the compound patent's expiry.

In Germany § 11 PatG defines one of the broadest research use exemptions that exist. It exempts all non-commercial research and trial activities as well as the "commercial" research *on* the patented subject from the fact of patent infringement. Research *with* the patented matter remains an infringing action. The differentiation between research *on* and *with* a patented matter allows for example the actions aimed at the enhancement of a patented subject as well as the performance of functional tests whereas it does not exempt the research use of research tools, like the Onco Mouse, without buying or licensing it. Moreover, § 11 PatG was extended by the Supreme Court's decisions "Clinical Trials I" and "Clinical Trials II" which exempted the research use of patented compounds – which would not have been exempted

*see 29 F.Cas. 1120, 1121 (C.C.D. Mass. 1813)

†see 733 F.2d 858, 865 (Fed. Cir. 1984)

by § 11 PatG – for equivalency tests, the provision of information and data for the admission procedures etc.[‡] These decisions correspond to the Bolar exemption implemented in the U.S. patent law.

This paper is motivated by the discussion about the effects of a research use exemption. From an economic perspective they are manifold – one main criticism against a narrow implementation of a research use exemption is that it hinders technological progress by impeding competitors the access to patented knowledge. In this article we take a different viewpoint by proposing that inventors may even *refrain* from patenting when they are confronted with a broad research use exemption, as then competitors can legally use the patented knowledge as input in their own research activities, making inventing around the patent easier.

A patent originally has two functions. First, it assigns a firm the temporary monopoly right to commercially exploit the patented idea. This enables the firm to appropriate the returns on R&D investments and represents the *protective effect* of a patent. Second, according to patent law a patent should contribute to the diffusion of knowledge by requiring the disclosure of the invention to society. We refer to this as the *disclosure effect* of a patent.[§] Consequently, an inventor when deciding whether to patent or not has to balance the tradeoff between the positive protective effect and the negative disclosure effect of a patent. The introduction or strengthening of a research use exemption underpins the disclosure effect of patenting in areas for which the exemption is applicable as it legalizes the use of the disclosed information for competing firms and at the same time weakens the protective effect.

Whenever an inventor decides to patent, his obtained monopoly rights may be infringed in two ways: either on the market for end-products or the market for technologies or both. Usually, patent infringement occurs on the product market, i.e. whenever a rival firm markets a product which incorporates some features of a patented product it built upon, it takes the risk of being prosecuted by its predecessor. On the market for technologies the occurrence of a patent infringement crucially depends on the existence or non-existence of a research use exemption: In the absence of a research use exemption, the use of knowledge which is patented by a third party without obtaining a license constitutes an infringement. This sort of infringement is ruled out if a research use exemption is in place as long as the patented knowledge is solely used for research purposes.

Relying on previous theoretical work on this issue (Zaby and Heger (2011))

[‡]For a thorough judicial investigation of the research use exemption in Germany and an examination of the court decisions “Clinical Trials I” and “Clinical Trials II” see ?.

[§]For a theoretical definition of these patenting effects see Zaby (2010).

we will empirically investigate whether a significant effect of the research use exemption on the propensity to patent exists. To do this we rely on a completely new data set which was created at the Centre for European Economic Research (ZEW) in Mannheim and the University of Tuebingen by using an online questionnaire. The innovative aspect of this survey compared to other innovation surveys, like the Community Innovation Survey (CIS), is that it is based on one specific research project of a firm. This allows us to exactly identify the causality between the driving forces behind the decision to patent (or choose an alternative protection strategy) for a given research project.

Besides the more “traditional” impact factors like R&D activities, firm size, exporting activities, the propensity to patent is also linked to the embodiment of the patent law and more specifically its perception. We look at the firms’ belief about the implemented research use exemption and its impact on the propensity to patent. This approach is inspired by ? who look at whether patents affect changes in academic scientists’ choice of research projects and find that changes in research projects are caused by scientist’s beliefs about whether a research use exemption exists.

Our research question is whether the belief about the extent of the research use exemption has an impact on the decision to patent. We hypothesize that a broader research use exemption will lead to a lower propensity to patent because the research uses are exempted from patent infringement. The combined effect of the research use exemption and the technological lead should be positive. Furthermore, we conjecture that if reverse engineering is relatively easy firms would more probably rely on patent protection. In line with our previous findings we would expect that firms were more reluctant to patent if their invention embodies a larger technological lead (Heger and Zaby (2009)). And finally, the higher the barriers to market entry the lower the propensity to patent (Zaby and Heger (2009)).

This paper is organized as follows: Section 2 reviews the literature on the propensity to patent and the research use exemption and Section 3 depicts our hypotheses we want to test in this paper. In Section 4 we describe data collection process and show some descriptive statistics. Section 5 discusses the results and Section 6 concludes.

2 Literature Review

It is widely acknowledged that not every innovation is patented although patents are often seen as an efficient vehicle to appropriate returns on R&D investment. A patent may contribute to the generation of revenue in two

ways: First, the patent holder is entitled to get the exclusive right to “prevent third parties not having the owner’s consent from the acts of: making, using, offering for sale, selling, or importing” (e.g. Art. 28 TRIPs Agreement) the product or process patented, i.e. the patent holder is the only one to fall to the commercial exploitation of the patented matter. Second, patent owners may “assign . . . the patent and to conclude licensing contracts” (Art. 28 TRIPs Agreement). Cohen et al. (2000) explain this stylized fact by basically two characteristics of a patent: First, in a patent application the firm discloses major parts of its invention and second with the aid of the disclosed information inventing around and launching a differentiated product gets easier for competitors (see e.g. Horstmann et al. (1985)). The reluctance of firms to patent even holds for different firm sizes (Arundel (2001)). Furthermore, the importance of patenting seems to be higher for commercialized inventions, whereas secrecy is more relevant for inventions which have not yet been launched (Hussinger (2006)).

The economic literature finds different factors which drive the propensity to patent. Looking at the protective effect the propensity to patent crucially depends on the precise implementation of the respective national patent law and particularly on the design of patent characteristics. The protective effect is negatively linked to the duration of the patent term (Gallini (1992) and positively to patent breadth (Gallini (1992)), Takalo (1998)).

Besides the design of patent law, the propensity to patent is also influenced by characteristics of the industry, the firm or the competitive situation. Scherer (1983) detects differences in the propensity to patent, measured as the number of patents obtained per R&D expenditures, across industries. Arundel and Kabla (1998) confirms this finding even if differentiating between product and process innovations. They find that the propensity to patent is particularly high in pharmaceuticals, chemicals, machinery and precision instruments. This could be explained by the degree of the easiness of reverse engineering. The propensity to patent is also related to firm size as patenting seems to be more important in larger firms than in SMEs (König and Licht (1995), Brouwer and Kleinknecht (1999)). The propensity to patent may be correlated with the height of the inventive step: Mäkinen (2007) and Kleinknecht and van der Panne (2009) find that breakthrough innovations are more often patented than incremental innovations whereas Heger and Zaby (2009) confirm the opposite effect that a higher technological lead decreases the propensity to patent. This result is reversed if the firms operate in industries characterized by a high usability of (unintended) knowledge spillovers.

To our best knowledge, no theoretical literature and only very sparse empirical literature exists which analyzes the impact of a research use exemption

on patenting activity. In two related papers, Nagaoka and Aoki (2006, 2007) building on Scotchmer (2004) analyze the effect of a research use exemption on the R&D activities of firms and find a positive effect. Thumm (2003) provides the only empirical survey which explicitly includes an investigation of the research use exemption. For the Swiss biotechnology sector, he finds that participants consider the introduction of a broad research use exemption relatively beneficial. He finds two main reasons as substantial for this positive assessment: a broad research use exemption increases the access to genetic inventions, and it promotes the dissemination of technology.

Most of the economic literature implicitly assumes that a research use exemption does not exist (or has a very low impact), as the disclosure effect of a patent is disregarded. Our work relates to several contributions which also consider that patenting has a disclosure effect, but disregard the interrelation of the disclosure effect with the legal implementation of a research use exemption. In the work of Scotchmer and Green (1990) and Erkal (2005) the extent of the disclosure requirement remains fixed whereas Bhattacharya and Guriev (2006), Aoki and Spiegel (2009) and Harter (1994) assume that the impact of the required disclosure may vary. However, the latter contributions do not explicitly focus on the consequences that a varying impact of the disclosure requirement has on the counter-effects of patenting and in the end on the propensity to patent. Aoki and Spiegel (2009) focus on the influence of alternative filing procedures on the propensity to patent, Bhattacharya and Guriev (2006) analyze the choice of alternative licensing contracts and Harter (1994) due to restrictive model assumptions comes to the conclusion that the propensity to patent is not at all influenced by the impact of the disclosure requirement.

3 Hypotheses

In this paper we investigate whether the firms' belief about the extent of the implemented research use exemption affects its propensity to patent. As with a broad definition of a research use exemption the disclosure effect is strengthened and at the same time the protective effect of a patent is derogated, the propensity to patent may be reduced if firms believe in a broad definition of exempted research use of patented knowledge.

Hypothesis 1 *The propensity to patent decreases if firms believe that the implemented research use exemption is broad.*

As shown by Scherer (1983) and Arundel and Kabla (1998) the propensity to patent differs across industries. Arundel and Kabla (1998) finds that the

propensity is particularly high in pharmaceuticals, chemicals, machinery and precision instruments. Those industries are characterized by products which are easy to reversely engineer. Therefore, we conjecture that the propensity to patent also depends on industry or technology characteristics, particularly on reverse engineering.

Hypothesis 2 *The propensity to patent decreases if reverse engineering is easy.*

Furthermore, the literature finds that the inventive step is a driving force of the propensity to patent. Although the effects are contradictory. Mäkinen (2007) and Kleinknecht and van der Panne (2009) confirm that a higher inventive step increases the propensity to patent whereas Heger and Zaby (2009) find that the overall effect is negative and the interaction effect of the inventive step and the easiness to use disclosed information results in a positive effect. Hence, we hypothesize:

Hypothesis 3

- a. The propensity to patent **increases** with the inventive step.*
- b. The propensity to patent **decreases** with the inventive step.*

Hypothesis 4 *The propensity to patent increases with the inventive step in areas in which reverse engineering is easy.*

4 Data Set

In order to answer the research question we use a data set on German innovative firms. Data gathering has been done by the means of an online questionnaire for a project within the scope of the SEEK research program carried out by the Centre for European Economic Research (ZEW) in Mannheim and the University of Tuebingen. The basis for the survey sample is the ZEW Enterprise Panel. In cooperation with Creditreform, Germany's largest credit rating agency, the ZEW builds a comprehensive data base on German firms including reliable information on the number of employees, sales, industry affiliation and legal form. To this end, the ZEW biannually gets the information of the thorough investigation process Creditreform conducts on the firms. As a starting point, we use information on firm name, address and industry assignment. Based on this data set we randomly drew a sample of 10,000 firms stratified by the following industries: chemicals, pharmaceuticals, machinery, optical devices, biotechnology, medical engineering, software

and R&D services. We chose those industries because according to the hightech industry definition those sectors are characterized by an industry R&D intensity of above 3.5%. Hence, we were confident that with this restriction we would include most potentially innovative firms. As the topic of the survey, the research exemption in patent law, is very specific we have drawn such a huge sample. Because of a very small response rate following our announcement by mail we decided to call a random sample of 2,000 firms with the same stratification scheme. If the firms signaled that they are prone to participate an email including a direct link to the online survey was sent which was the case for almost 30% of the calls. If the firm indicated that they do not intend to participate we asked them for the reasons. They mostly told us that they did not have time, were not interested in the topic or were not innovative. A minor role played the firm size, particularly if they thought they were too small they renounced to participate. Taking a closer look on the firms out of the 2,000 which decided not to take part of the survey we found that one third was just not interested, 23% were heavily time constrained, and almost 20% stated that they were not in the focus of our study, i.e. they did not conduct R&D or innovation activities. In 22% of the cases, we encountered problems with the telephone number. Personal reasons, firm size or firm closure played a very minor role in the nonresponse. Before starting this investigation, we suspected that many firms would renounce participation because they feared to disclose too much of their most valuable innovation project and their IP strategy. But this turned out to be not true.

In total, 398 firms answered the survey. The focus of the survey is on innovative firms so that we included a screening at the beginning of the survey and ask whether they conduct or contract R&D or whether they work on at least one innovation project, two third of the respondents have one of those characteristics. After some data cleaning, we ended up with a data set of 192 observations.

This data set remedies a caveat of many surveys regarding innovation activities and their protection: Usually those surveys focus on the firm level, like the Community Innovation Survey (CIS). As firms, particularly if they are of a certain size, typically conduct several innovation projects and choose different IP protection strategies for their various projects, it is difficult to disentangle the impact factors affecting the patenting decision. Our data set traces one innovation project. We collect information on the project volume, the intended outcome (product, process etc.), the newness of the innovation as well as the protection strategy. Besides the project information we also ask for firm characteristics like the number of employees, exporting activities and the sales figure.

The central variable of this paper is the question on the firms' belief about

the extent of the research use exemption. We ask the respondents to assess a number of statements concerning the national patent law. The categories that could be chosen were “applies”, “does not apply”, “would be nice to have” and “I don’t know”. The list of statements is:

1. Firms are allowed to *refine and develop* new applications for patented *research tools* without the patent holders permission.
2. Firms are allowed to *refine and develop* new applications for patented *know-how and material* without the patent holders permission.
3. Firms are allowed to perform *validity test* for patented *research tools* without the patent holders permission.
4. Firms are allowed to perform *validity test* for patented *know-how and material* without the patent holders permission.
5. Firms are allowed to *unvariedly* use patented *research tools* as part of their own products or processes without the patent holders permission.
6. Firms are allowed to *unvariedly* use patented *know-how and material* as part of their own products or processes without the patent holders permission.
7. Firms are allowed to conduct *research and clinical trials with patented compounds before the end of the patent period* if targeted towards drug approval.

In order to evaluate the firms’ belief about the nationally implemented research use exemption, we construct an index by confronting their answers with the legal definition of the research use exemption. This approach is similar to the one in ?. According to §11 PatG, the statements 1, 2, 3, 4 and 7 correspond to the implemented research use exemption in Germany. For the correct statements we count “applies”, for the incorrect statements “does not apply” and “would be nice to have” and viceversa. We then build a sum of answers which are in line with the implementation of the research use exemption. This sum is divided by the number of statements that have been evaluated in order to get a score of how well the belief matches with the legal implementation of the research use exemption. This score basically reflects the correspondence of the firms’ belief with the actual legal implementation of the research use exemption. As we conjecture that firms respond to the breadth of the research use exemption, we also construct an alternative measure by counting all the responses that stated “applies” leveled by the number

of answered statements. Hence, this measure reflects the firms' assessment of how broad they think the implemented research use exemption is.

As we asked the firms about the number of employees and sales in the years 2009 and 2010 and many innovation projects already started before, we use the information from the ZEW Enterprise Panel to the relevant information for the year before project start. Moreover, we include the industry affiliation and the legal form.

Descriptive Statistics

Table 1 depicts the descriptive statistics of the variables we include in our estimation. Our dependent variable is *patent* which reflects whether the firm applied for a patent to protect their intellectual property generated while conducting the respective innovation project. About 25% of the firms applied for patent. 38% of the assessment of the average surveyed firm with respect to the extent of the national research use exemption correspond to the actual implementation (*belief_rue*). *The variable belief_broad displays whether the firms ticked "applies" to the seven statements. If they do for all seven statements their perception, about what is exempted, is that the research use exemption is broader than it actually is.*

Table 1: Descriptive Statistics

	Mean	Std. Dev.	Min	Max
<i>patent</i>	0.245	0.431	0	1
<i>belief_rue</i>	0.381	0.229	0.000	1.000
<i>belief_broad</i>	0.150	0.248	0.000	1.000
<i>reverse engineering</i>	0.129	0.336	0	1
<i>technological lead</i>	0.171	0.378	0	1
<i>log(employees)</i>	3.174	2.125	0.000	11.613
<i>log(volume per man month)</i>	4.204	4.377	0.000	11.567
<i>foreign markets</i>	0.297	0.458	0	1
<i>internal R&D</i>	0.453	0.499	0	1
<i>R&D cooperation</i>	0.474	0.501	0	1
<i>duration</i>	2.307	3.511	0.000	38
<i>res.tool & materials</i>	0.240	0.428	0	1
<i>product sale</i>	0.641	0.481	0	1
<i>new to world</i>	0.401	0.491	0	1
<i>No. of observation</i>		192		

To be able to assess whether the firms are subject to easy reverse engineering we asked them whether an expert skilled in the art would easily be able to re-engineer the firm's invention. The respondents answered using a 7-digit Likert scale ranging from "extremely easy" (1) to "extremely difficult" (7). If the firms ticked (1) or (2) we assume that reverse engineering is easy. This is the case for 13% of the respondents. To capture the technological lead of the invention we use a similar question on whether competitors would be able to enter the market with a related product if the firm's invention has already been launched but would not be protected by a patent. If the respondents ticked that competitors would "never" be able to enter the market (7) or (6) we assume that the technological lead is fairly high.

We further control for firm size by the number of employees and whether the firm is active in foreign markets outside the EU. Furthermore, we include some characteristics about the innovation project. We use the variable volume per man month to control for the importance of the project for the firm. This variable is constructed by divided the ex ante project volume with the number of man months. Furthermore, we control for the duration of the innovation

project, whether the R&D activities are conducted internally (internal R&D) or in cooperation with another firm or university (R&D cooperation). Finally, we account for some characteristics of the envisaged innovation: res.tool & materials reflect whether the invention is a research tool or a material which would not be sold on an end-product market so that a different rationing about how protect this innovation may apply. product sale shows whether the innovation is intended to be sold regardless whether it is an end-product, research tool or material. The bas category in this case would be that the innovation is only intended to be used by the firm itself. new to world reflects whether the innovation is new to the world.

5 Empirical Results

Table 2 displays the marginal effects of our probit estimations. Equation (1) is the basis estimation. In estimation (2) we further include whether reverse engineering is easy and probit (3) shows the results if we include technological lead. On top we insert the interaction term of reverse engineering and technological lead in equation (4). And finally, probit (5) depicts the results of the alternative measure of the belief about the implemented research use exemption.

Table 2: Marginal Effects for Propensity to Patent

	(1)	(2)	(3)	(4)	(5)
	Marg.Eff. (Std.Err.)	Marg.Eff. (Std.Err.)	Marg.Eff. (Std.Err.)	Marg.Eff. (Std.Err.)	Marg.Eff. (Std.Err.)
<i>belief_rue</i>	0.192** (0.092)	0.194** (0.093)	0.193** (0.091)	0.168* (0.090)	
<i>belief_broad</i>					0.091 (0.094)
<i>reverse engineering</i>		0.133** (0.058)	0.165*** (0.059)	0.206*** (0.060)	
<i>technological lead</i>			0.086 (0.059)	0.123** (0.060)	
<i>log(employees)</i>	0.027** (0.013)	0.027** (0.012)	0.026** (0.012)	0.024** (0.012)	0.030** (0.013)
<i>log(volume per man month)</i>	0.007 (0.010)	0.006 (0.010)	0.006 (0.010)	0.007 (0.009)	0.007 (0.010)
<i>volmonth_missing</i>	0.066 (0.117)	0.026 (0.118)	0.026 (0.121)	0.016 (0.121)	0.075 (0.117)
<i>foreign markets</i>	0.022 (0.055)	-0.002 (0.056)	-0.017 (0.057)	-0.006 (0.056)	0.016 (0.056)
<i>internal R&D</i>	0.095* (0.055)	0.067 (0.058)	0.051 (0.058)	0.040 (0.057)	0.107* (0.057)
<i>R&D cooperation</i>	-0.063 (0.060)	-0.069 (0.060)	-0.074 (0.061)	-0.110* (0.063)	-0.057 (0.060)
<i>duration</i>	0.006 (0.006)	0.005 (0.006)	0.007 (0.006)	0.007 (0.006)	0.007 (0.006)
<i>res.tool & materials</i>	0.131** (0.051)	0.120** (0.052)	0.110** (0.052)	0.087 (0.053)	0.137*** (0.052)
<i>product sale</i>	0.154* (0.093)	0.129 (0.099)	0.127 (0.097)	0.140 (0.094)	0.170* (0.097)
<i>new to world</i>	0.184*** (0.045)	0.163*** (0.046)	0.152*** (0.048)	0.170*** (0.047)	0.195*** (0.045)
<i>abandoned</i>	-0.111 (0.100)	-0.129 (0.097)	-0.114 (0.097)	-0.105 (0.094)	-0.122 (0.099)
<i>industry dummies</i>			<i>included</i>		
<i>No. of observation</i>			192		

*** (**, *) indicate significance of 1 % (5 %, 10 %) respectively.

We find a positive impact of the belief about the research use exemption on

the propensity to patent which contradicts our Hypothesis 1. However, this variable captures the correct assessment about the implemented exemption. This may reflect the fact the awareness of the firms that others may use their patented knowledge as input in their research process but when they launch the innovation they are to make sure that this is not infringing the patent used. Hence, if the competitors were not able to differentiate their innovation in a way that is not infringing the patent, this competitor must license the patent. If the competitors succeed in developing a new non-infringing innovation this new product might maybe cover a diverse market segment.

If reverse engineering is easy the innovators are more inclined to patent their invention in order to protect it from imitation (probit (2)) which confirms Hypothesis 2. The inventive step (reflected by the technological lead) as such has no impact on the propensity to patent. Hence, we can neither confirm nor reject Hypothesis 3 (probit (3)). If we include the interaction term of reverse engineering and technological lead we find a positive impact of the technological lead (probit (4)). This may confirm Hypothesis 4 as the interaction term obviously drives this effect. Hence, if firms are active in markets which are characterized by reverse engineering they are prone to patent their invention incorporating a large technological lead.

As concerns the control variables we find that firm size, new to the world products and the fact that the innovation is either a research tool or a material has a positive impact on the propensity to patent.

6 Concluding Remarks

This paper tries to analyze the effect of the research use exemption on a firm's propensity to patent. As the research use of a patent is exempted firms may be reluctant to patent because they know that their patented knowledge may benefit their competitors. Our empirical analyses, however, reveal that the research use exemption does even increase the propensity to patent even if we control for reverse engineering. Probably firms are aware that the innovation of the competitor using their patents must be different enough to their innovation. If this is not the case the innovation – if launched to the market – infringes the patented product of the innovator. Hence, if the competitor behaves within the legal framework it must license. Furthermore, the innovation of the competitor may benefit the innovator in the future.

References

- Aoki, R. and Spiegel, Y.: 2009, *Pre-grant patent publication and cumulative innovation*, *International Journal of Industrial Organization* **27**, 333–345.
- Arundel, A.: 2001, *The relative effectiveness of patents and secrecy for appropriation*, *Research Policy* **30**, 611–624.
- Arundel, A. and Kabla, I.: 1998, *What percentage of innovations are patented? Empirical estimates for european firms*, *Research Policy* **27**, 127–141.
- Bhattacharya, S. and Guriev, S.: 2006, *Patents vs. trade secrets: Knowledge licensing and spillover*, *Journal of the European Economic Association* **4**(6), 1112–1147.
- Brouwer, E. and Kleinknecht, A.: 1999, *Innovative output and a firm's propensity to patent. an exploration of cis micro data*, *Research Policy* **28**, 615–624.
- Cohen, W., Nelson, R. and Walsh, J.: 2000, *Protecting their intellectual assets: Appropriability conditions and why U. S. manufacturing firms patent (or not)*, NBER working paper **7552**.
- Erkal, N.: 2005, *The decision to patent, cumulative innovation, and optimal policy*, *International Journal of Industrial Organization* **23**, 535–562.
- Gallini, N. T.: 1992, *Patent policy and costly imitation*, *RAND Journal of Economics* **23**, 52–63.
- Harter, J. F.: 1994, *The propensity to patent with differentiated products*, *Southern Economic Journal* **61**, 195–201.
- Heger, D. and Zaby, A. K.: 2009, *The propensity to patent with vertically differentiated products – an empirical investigation*, *Tübinger Diskussionsbeitrag Nr. 325*.
- Horstmann, I., MacDonald, G. M. and Slivinsky, A.: 1985, *Patents as information transfer mechanisms: to patent or (maybe) not to patent*, *Journal of Political Economy* **93**, 837–858.
- Hussinger, K.: 2006, *Is silence golden? Patents versus secrecy at the firm level*, *Economics of Innovation and New Technology* **15**, 735–752.

- Kleinknecht, A. and van der Panne, G.: 2009, *The propensity to patent an innovation: Comparing entrepreneurial to routinized innovators*, Mimeo.
- König, H. and Licht, G.: 1995, *Patents, R&D and innovation: Evidence from the Mannheim Innovation Panel*, Ifo-Studien **33**, 521–543.
- Mäkinen, I.: 2007, *To patent or not to patent? an innovation-level investigation of the propensity to patent*, VTT Publications **646**, 1–95.
- Nagaoka, S. and Aoki, R.: 2006, *Economics of research exemption*, IIR Working paper 06-04. Institute of Innovation Research, Hitotsubashi University.
- Nagaoka, S. and Aoki, R.: 2007, *Economic analysis of patent law exemption for research on a patented innovation*, Mimeo.
- Scherer, F. M.: 1983, *The propensity to patent*, International Journal of Industrial Organization **1**, 107–128.
- Scotchmer, S.: 2004, *Innovation and Incentives*, The MIT Press, Cambridge, MA.
- Scotchmer, S. and Green, J.: 1990, *Novelty and disclosure in patent law*, RAND Journal of Economics **21**(1), 131–146.
- Takalo, T.: 1998, *Innovation and imitation under imperfect patent protection*, Journal of Economics **67**, 229–241.
- Thumm, N.: 2003, *Research and patenting in biotechnology. a survey of switzerland.*, Publication No 1 (12.03), Swiss Federal Institute of Intellectual Property .
- Zaby, A. K.: 2010, *The decision to patent*, Springer Heidelberg.
- Zaby, A. K. and Heger, D.: 2009, *The propensity to patent with horizontally differentiated products – an empirical investigation*, Tübinger Diskussionsbeitrag Nr. 324.
- Zaby, A. K. and Heger, D.: 2011, *The research use exemption from patent infringement, the propensity to patent and pace of technological progress*, Unpublished manuscript.