Seeing One's Hopes Dashed? Empirical Evidence on the Impact of the Research Use Exemption 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Preliminary Version – Please do not quote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 use exemption is statutory or is examined on a case by case basis. The research use 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

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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[1] 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 [2]. 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

[1] see 29 F.Cas. 1120, 1121 (C.C.D. Mass. 1813)
[2] 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.[3] 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.[4] 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 (**?**) we will empirically

[3]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 Holzapfel (2004).

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

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 Jensen and Webster (2010) 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. 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)).
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 3 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 exemp-

tion 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. There is not much literature linking the research use exemption to the propensity to patent. We are developing a theoretical model which (very preliminary) result is that the research use exemption has a negative impact on the propensity to patent. Hence, 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 the research use exemption. But the research use exemption is supposed to increase firms' research activities. This is shown by **?**. Hence, if research efforts are increased the probability of creating an innovation increases as well and this in turn may increase the propensity to patent. Furthermore, the research use exemption only exempts the research use of patented knowledge. When it comes to the commercialization of the new invention this product must still be non-infringing to the innovator's patent. If this is not the case, the competitor must pay a license to the patentholder or find any other settlement to the following litigation.If the

new product is non-infringing, it must be diverse enough with respect to the original patent. Hence, if the risk of successful inventing around by competitors is low the propensity to patent may increase. This leads to two hypotheses concerning the impact of the research use exemption on the propensity to patent:

Hypothesis 1
a. *The propensity to patent **de**creases if firms believe that the implemented research use exemption is broad.*
b. *The propensity to patent **in**creases 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) find that the propensity is particularly high in pharmaceuticals, chemicals, machinery and precision instruments. Those industries are characterized by products which are easy to re-engineer. Since in those industries it is easy to re-build the invention based on the marketed product, the additional disclosure effect of a patent is minimal and is outweighed by its protective effect. Hence, under those circumstances firms would be more prone to patent their inventions. 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 increases if reverse engineering is easy.*

Furthermore, patenting may depend on the characteristics of the invention, particularly, on the height of the inventive step. 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 in their theoretical model that the extent of the technological lead reduces the propensity to patent. Only in industries characterized by a high level of substitutability of the products this effect is reversed. In the empirical part, they confirm the positive effect of the interaction between the technological lead and the substitutability. However, the overall effect of technological lead turns out to be insignificant pointing at the fact that the countervailing effects of technological lead and substitutability cancel each other out. Hence, we hypothesize:

Hypothesis 3
a. *The propensity to patent **in**creases with the inventive step.*
b. *The propensity to patent **de**creases with the inventive step.*

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 the hightech industry definition those sectors are characterized by an industry R&D intensity of above 3.5% (for details on the classification see B. Gehrke (2010)). 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 inno-

vative 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 repondents to assess a number of statements concerning the national patent law. The categories that could be chosen where "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 Jensen and Webster (2010). 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 sum the answers which are in line with the German implementation of the research use exemption. This sum is divided by the number of statements that have been evaluated by the firm in order to get a score of how well the belief matches with the legal implementation of the research use exemption given that the firm has responded to the specific statement. This score basically reflects the correspondence of the firms' belief with the actual legal implementation of the research use exemption. This variable is called *belief_rue*. 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. This variable is called *belief_broad*.
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 form 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 one fourth of the firms applied for a patent. Looking at the extent of how much the belief and the actual implementation of the research use exemption correspond, on average 38% of the assessment match (*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**
patent	0.240	0.428	0	1
belief_rue	0.384	0.223	0.000	1.000
belief_broad	0.143	0.239	0.000	1.000
reverse engineering	0.126	0.332	0	1
technological lead	0.171	0.378	0	1
log(employees)	3.198	2.180	0.000	11.613
log(volume per man month)	3.871	4.355	0.000	11.567
foreign markets	0.286	0.453	0	1
internal R&D	0.451	0.499	0	1
R&D cooperation	0.463	0.500	0	1
ln(duration)	0.855	0.749	0.000	3.664
res.tool & materials	0.240	0.428	0	1
innovation sale	0.617	0.487	0	1
new to world	0.400	0.491	0	1
No. of observation		175		

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 about 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. The respondents answered using a 7-digit Likert scale. If the respondents ticked that competitors would "never" be able to enter the market (7) to (5) we assume that the technological lead is fairly high.
Regarding the control variables we include some firm characteristics like firm size represented by the number of *employees*. Furthermore, we account for whether the firm is active in *foreign markets* outside the EU. This is our proxy for exporting activities which may influence innovation activities positively as many studies showed. Furthermore, we include some characteristics

about the innovation project. Two variables should reflect the relevance of the innovation project for the firm: First, its *duration* which is constructed by subtracting the year of project start from the date of product launch. Second, we asked the firms to tell the project volume and the number of man month dedicated to the project. Controlling for the *volume per man month* displays the firm's stake at risk and may also lead to a higher propensity to patent. Furthermore, we include an indicator 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 to protect this innovation may apply. Since both innovation outputs are intended to be the input to other firms' research processes the propensity to patent should be increasing because the only way to cash from those innovations is by licensing out or selling them. *innovation sale* shows whether the innovation is intended to be sold regardless whether it is an end-product, research tool or material. The base category in this case would be that the innovation is only intended to be used only by the firm itself. *new to world* reflects whether the innovation is new to the world.

5 Empirical Results

Table 3 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.

Table 2: Marginal Effects for Propensity to Patent 1

	(1)	**(2)**	**(3)**
	Marg.Eff.	**Marg.Eff.**	**Marg.Eff.**
	(Std.Err.)	**(Std.Err.)**	**(Std.Err.)**
belief_rue	0.179*	0.183**	0.189**
	(0.093)	(0.089)	(0.083)
reverse engineering		0.143**	0.171***
		(0.053)	(0.057)
technological lead			0.099
			(0.058)
log(employees)	0.025*	0.025*	0.026*
	(0.014)	(0.013)	(0.013)
log(volume per man month	0.004	0.004	0.005
	(0.010)	(0.009)	(0.009)
volmonth_missing	0.016	-0.011	0.002
	(0.108)	(0.104)	(0.099)
foreign markets	-0.006	-0.008	-0.021
	(0.054)	(0.053)	(0.052)
internal R&D	0.082	0.052	0.032
	(0.058)	(0.052)	(0.054)
R&D cooperation	-0.091	-0.087	-0.103
	(0.056)	(0.054)	(0.060)
ln(duration)	0.070	0.070*	0.085*
	(0.043)	(0.040)	(0.042)
res.tool & materials	0.133**	0.120**	0.104**
	(0.050)	(0.047)	(0.047)
innovation sale	0.118	0.104	0.093
	(0.076)	(0.066)	(0.067)
new to world	0.149***	0.136**	0.139***
	(0.050)	(0.051)	(0.050)
abandoned	-0.152	-0.147	-0.119
	(0.109)	(0.101)	(0.100)
industry dummies		*included*	
No. of observation		175	

*** (**, *) indicate significance of 1 % (5 %, 10 %) respectively.
This table depicts marginal effects of a probit estimation regarding the determinants of the patenting decision. Marginal effects are calculated at the sample means and standard errors are calculated with the delta method.

Table 3: Marginal Effects for Propensity to Patent 2

	(1)	**(2)**	**(3)**
	Marg.Eff.	**Marg.Eff.**	**Marg.Eff.**
	(Std.Err.)	**(Std.Err.)**	**(Std.Err.)**
belief_broad	0.152	0.169*	0.171*
	(0.101)	(0.096)	(0.092)
reverse engineering		0.145***	0.174***
		(0.052)	(0.058)
technological lead			0.096
			(0.060)
log(employees)	0.026*	0.026*	0.027*
	(0.014)	(0.013)	(0.013)
log(volume per man month	0.003	0.003	0.003
	(0.010)	(0.009)	(0.009)
volmonth_missing	0.011	-0.018	-0.004
	(0.107)	(0.103)	(0.099)
foreign markets	-0.020	-0.024	-0.036
	(0.055)	(0.054)	(0.053)
internal R&D	0.092	0.064	0.044
	(0.057)	(0.051)	(0.053)
R&D cooperation	-0.086	-0.082	-0.098
	(0.057)	(0.055)	(0.060)
ln(duration)	0.076*	0.076*	0.091**
	(0.044)	(0.041)	(0.042)
res.tool & materials	0.117	0.101	0.091
	(0.081)	(0.071)	(0.073)
innovation sale	0.117	0.101	0.091
	(0.081)	(0.071)	(0.073)
new to world	0.155***	0.141***	0.145***
	(0.050)	(0.050)	(0.049)
abandoned	-0.159	-0.156	-0.130
	(0.108)	(0.101)	(0.100)
industry dummies		*included*	
No. of observation		175	

*** (**, *) indicate significance of 1 % (5 %, 10 %) respectively.
This table depicts marginal effects of a probit estimation regarding the determinants of the patenting decision. Marginal effects are calculated at the sample means and standard errors are calculated with the delta method.

We find a positive impact of the belief about the research use exemption on the propensity to patent which confirms our Hypothesis 1. Since this

variable captures the correct assessment about the implemented exemption this may reflect the fact that due to the research use exemption research activities may be enforced so that this effect may reflect the firms' increasing innovation activities. And maybe firms are aware that even with a research use exemption the exclusive right to commercialize the patented knowledge is not reduced. 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 then cover a diverse market segment.

Regarding our alternative measure of the belief about the implemented research use exemption reflecting an even broader definition. This definition also "allows" for a legal commercialization of a pure imitation of the patented matter. In specification (2) and (3) the effect turns out to be slightly positive. This result may be surprising since this version of the belief about the research use exemption obviously strengthens the disclosure effect to such an extent that the protective effect could never outweigh it. However, looking at the descriptive statistics reveals that much less firms believe in a very broad definition of the research use exemption. Hence, the large majority of firms did not believe that an imitating use of the patented invention is legalized. Therefore, these results resemble the previous ones.

If reverse engineering is easy the innovators are more inclined to patent their invention in order to protect it from imitation (probit (2) and (3)) which confirms Hypothesis 2. The inventive step (reflected by the technological lead) has a positive impact on the propensity to patent confirming Hypothesis 3a and is in line with the result of Mäkinen (2007) and Kleinknecht and van der Panne (2009).

Concerning the controls we find that the propensity to patent is increasing in firm size and the newness of the innovation. Furthermore, compared to developing end-products the fact that the innovation activities result in a research tool or material increases the propensity to patent. As those innovations are only used as inputs in research processes the only way of generating some return is to patent the research tool or material. As regards the duration of the innovation project we find a weak significant positive effect in only one specification. this might hint at an increasing propensity to patent in response to an increasing duration of the project. Finally, the effect of cooperation in R&D activities turns out to be weakly significant and negative in only one specification. The variable cooperation combines joint R&D activities with firms and/or universities. almost 70% of the R&D cooperations are with universities so that the reluctance of universities to patent their inventions may drive this (weak) effect.

6 Concluding Remarks

This paper focuses on the impact of the research use exemption on a firm's propensity to patent. Because of the scarcity of previous literature regarding this issue our hypotheses in this respect are conflicting. Building on the very preliminary results of a theoretical model by ourselves we hypothesize that a broader definition of the research use exemption reduces the propensity to patent as competitors may benefit to a larger extent. However, the research use exemption is intended to increase the R&D effort (which is shown by **?**) and hence contributes to increasing innovation activities which in turn results in a higher propensity to patent. Our empirical results confirm the latter. Hence, the introduction and expansion of a research use exemption does not harm corporate patenting so that the diffusion of knowledge via the patent system may be even improved with a broader definition of the research use exemption as the research activities on the patented matter are exempted of patent infringement. However, our descriptive statistics reveal that firms' knowledge about the implemented research use exemption is quite scarce.
Besides the definition of the patent law and jurisdiction another factor which may affect firms' patenting decision is whether it is easy to re-engineer a product launched to the market if it is not protected by a patent. If reverse engineering is easy firms are more inclined to patent their inventions. Finally, we test whether the inventive step incorporated in an innovation has an impact on the propensity to patent. Heger and Zaby (2009) find that the technological lead reduces the propensity to patent as, in light o the disclosure requirement, the firms' competitors may benefit too much of the enabling knowledge. However, Mäkinen (2007) and Kleinknecht and van der Panne (2009) find that with a certain inventive step the propensity to patent increases. Our results confirm the latter.
An exceptional result of this study is the consistent increase in the propensity to patent if the innovation activities resulted in a research tool or material rather than in an end-product. The use of a research tool or material within another firms' research process constitutes an infringing act even under a broad definition of the research use exemption. The only purpose of a research tool and material is to be an input to a research process. But as opposed to the research use exemption it is not the patent and its incorporated idea that is used as the starting point of the R&D process but the "product" itself. In that it is an example of research *with* (the aid of) the patented matter which is not exempted.

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