The Research Use Exemption from Patent Infringement and the Propensity to Patent

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Abstract

This article explores the propensity to patent in the light of the research use exemption from patent infringement. Unlike earlier approaches concerned with the patenting decision, we take into account that a disclosure effect determined by the extent of a research use exemption may decrease the merits of patenting by facilitating inventing around the patent. We find that the extent of a research use exemption – contingent on the competitive environment of the inventor – possibly has substantial negative effects on the propensity to patent. An empirical investigation of the theoretical results finds support for the proposed effects.

Keywords: research use exemption, patenting decision, secrecy, disclosure requirement, patent breadth, horizontal product differentiation, circular city

JEL Classifications: L13, L24, O34

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1 Introduction

In Europe, most recently Belgium and Switzerland amended their statutory patent law to include a research use exemption from patent infringement. In other countries, where a statutory research use exemption does (de facto) not exist, e.g. Australia, New Zealand, or where its application is not clearly defined, e.g. the U.S., U.K., a continuous discussion about the usefulness of the introduction (or extension/clarification) of a research use exemption is taking place.

In the U.S. a research use exemption exists but its practical and legal implementation provokes uncertainty for firms relying on patented knowledge for their research activities. The first evidence for a research use exemption dates back to the decision in the case Whittemore v. Cutter in the year 1813 (29 F.Cas. 1120, 1121 (C.C.D. Mass. 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". In subsequent law suits the exemption was interpreted quite restrictively, particularly if firms were suspected to use their findings based on patented knowledge commercially. A statutory research use exemption for generic drugs was introduced after the Roche v. Bolar decision (733 F.2d 858, 865 (Fed. Cir. 1984)) in which it was found that "Bolar's intended 'experimental' use is solely for business reasons and not for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry". 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". Subsequent laws suits like Scripps v. Genentech (927 F.2d 1565, 18 USPQ 2d 1001 (Fed. Cir. 1991)) or Integra v. Merck (331 F.3d 860 863 865 (Fed.Cir. 2003)) interpreted the Bolar exemption restrictively by pointing out that – at least parts of – the research use would not be embraced by 35 U.S.C. § 271 (e) (see also *Kumar et al.* (2010)).

In contrast to this, in Eli Lilly v. Medtronic the exemption codified in § 271 (e) was extended to medical devices if intended for admission to the market. Medtronic invented an automatic implantable defibrillator which was an enhancement of Lilly's patents for an implantable defibrillator technology. Medtronic claimed that they conducted an evaluation for the admission procedure at the Food and Drug Administration (FDA). They referred to 35 U.S.C. § 271 (e) stating that the same reasoning as to drugs also applies to medical devices. The Supreme Court supported this point of view (496 U.S. 661 (1990). 15 USPQ2d 1121 (S. Ct. 1990)) since the suspectedly infringing medical device was an enhancement of the patented device and was foreseen for the admission procedure of the FDA. Hence, there is some exemption from patent infringement for the research use but its interpretation is made on a case-by-case basis which creates uncertainty for the firms using patented knowledge for their research activities.

In Germany § 11 PatG defines a broad research use exemption which includes all non-commercial research and trial activities as well as the research *on* the patented subject. Research *with* the patented matter remains an infringing action. Furthermore, § 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 by § 11 PatG – for equivalency tests, the provision of information and data for the admission procedures etc. This allows generic drug producers to enter the market at the time of the compound patent's expiry[1].

This paper is motivated by the ongoing discussion regarding 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.

Understanding a patent according to the original sense of patent law, it basically has two functions: The first is to mitigate the problem of unintended spillover of R&D outcomes by providing an effective tool of temporary knowledge protection. This protective effect of a patent enables the inventor to appropriate the returns from his research efforts. The second function of a patent is to contribute to the diffusion of inventions by requiring the disclosure of the invention to society. A broad interpretation of an exemption from patent infringement strengthens this negative disclosure effect of patenting in areas for which the exemption is applicable. Thus the question arises whether a broad research use exemption has a detrimental effect on the propensity to

[1]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).

patent.
Our investigation looks at the impact of the disclosure effect on the propensity to patent in the light of an existing research use exemption. We assume that the disclosure of knowledge inherent to a patent system only has an impact on the patenting decision if the research use of the patented knowledge is exempted. Our understanding is that the relevancy of the disclosure effect depends (*i*) on how broad a research use exemption is implemented in a country and (*ii*) how relevant the disclosed information is for the patentee's competitors. It is quite straightforward that firms will benefit from a research use exemption when the exempted knowledge forms the basis for their own further research. Nevertheless, they are not only consumers of previous innovations, but also producers of innovations in the future. We aim to tackle the question how the extent of the disclosure effect defined indirectly by the broadness of the nationwide implemented research use exemption influences an innovator's propensity to patent if his proprietary innovation serves competitors as input for their research.
To be able to analyze the impact of the extent of the disclosure effect on the propensity to patent we need a setting in which patent protection is imperfect, i.e. competitors have the possibility to legally invent around a patent. Further, the mandatory disclosure of information if the innovator patents should be profitable for competitors subject to the impact of the research use exemption. Our theoretical analysis builds on a model presented in *Zaby* (2010). To capture imperfect patent protection, the decision to patent is introduced into a setting with horizontally differentiated products where competitors may enter the market despite of a patent, i.e. invent around the patent.[2] The impact of a research use exemption transmitted by the relevancy of the disclosure effect influences the easiness of inventing around the patent. Whenever the research use exemption has a substantial impact, the mandatorily disclosed information in a patent specification profits the innovator's competitors as inventing around becomes easier. The inventor has to balance this negative effect of patenting against the positive protective effect. This positive effect stems from the fact that a patent restricts the

[2]Introducing patent protection into a setting with horizontally differentiated products goes back to *Klemperer* (1990).The main focus of his paper is to analyze a patent's optimal design with regard to its length and breadth, whereas the patenting decision per se is not considered. This is accomplished by two subsequent papers: *Waterson* (1990) focusses on a comparison of alternative patent systems with regard to social welfare, and *Harter* (1994) examines the propensity to patent accounting for a disclosure effect. The major drawback of the latter modeling approach is that only one potential competitor profits from the merits of the mandatory disclosure. This fact, which largely delimitates the impact of the disclosure requirement, in the end leads *Harter* (1994) to conclude that there is no causal relation between the required disclosure and the propensity to patent.

strategies of competitors: The broader the scope of the patent, the narrower is the area in which competitors may enter the market without infringing the patent.

Our main finding is that the weaker the impact of the disclosure effect – defined by the national interpretation of the research use exemption and the relevancy of the disclosed information for competitors – the higher is the propensity to patent. Subsequent to the theoretical analysis we investigate our findings empirically. Due to the fact that Germany implemented one of the broadest definitions of a research use exemption in Europe (*OECD* (2006)), we concentrate our empirical analysis on German firms.

To our best knowledge, besides own previous work, 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*, *Aoki* (2006, 2007) building on *Scotchmer* (2004) analyze the effect of a research use exemption on the R&D activities of firms. Concerning the impact of a research use exemption on the propensity to patent to our best knowledge no theoretical approach exists so far. *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*, *Green* (1990) and *Erkal* (2005) the extent of the disclosure requirement remains fixed whereas *Bhattacharya*, *Guriev* (2006), *Aoki*, *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*, *Spiegel* (2009) focus on the influence of alternative filing procedures on the propensity to patent, *Bhattacharya*, *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.

Our analysis proceeds as follows. In Section 2 we introduce the theoretical model. The considered three stage game is solved backward, beginning with the analysis of the price competition on the last stage of the game in Section 2.1, proceeding with the market entry decisions on the second stage of the game in Section 2.2 and finally the innovator's patenting decision on the first stage of the game in Section 2.3. The empirical investigation of our theoretical findings is presented in Section 3. Section 4 concludes. Proofs can be found in *Zaby* (2010).

2 The Model

Assume that one of n firms engaged in an innovation race has successfully accomplished a drastic product innovation which it brings to the market after deciding whether to protect it by a patent or by secrecy. The innovator will be monopolist in the new market as long as no other firm successfully innovates. The new product may be varied horizontally in its product characteristics which are assumed to be continuously distributed on a circle of unit-circumference. The innovator (and any other entering firm) can only offer one variant of the good. We denote the total number of firms that operate in this differentiated oligopoly as $N = n + 1$, consisting of the innovator and n entering firms. Consumers are assumed to be uniformly distributed over the circle, with density normalized to one. The preference of a consumer z is given by his position on the circle, $x_z \in [0, 1]$, and we assume without loss of generality that the innovator of the new product, denoted by the index ν, is located at $x_\nu = 0$. If a consumer cannot buy a good according to his preference he incurs a disutility that rises quadratically with the distance between his preferred good and the offered good. We will refer to this disutility as mismatch costs. Each consumer purchases one unit of the good which yields the highest net utility, $U_x = v - p_z - (x - x_z)^2 \geq 0$. We assume throughout the paper that the reservation price v is very high so that no consumer prefers the outside option.[3]

The structure of the model is as follows: on the first stage of a three-stage game the innovator decides whether to patent his innovation or to keep it secret, $\sigma_\nu^1 = \{\phi, s\}$. A patent protects a given range of product space on the unit circle against the entry of rival firms. The extent of protection is defined by the breadth of the patent, $\beta \in]0, 1[$, which is exogenously given.[4] We

[3]See *Zaby* (2010) for a relaxation of this assumption.

[4]Contrasting this assumption patent breadth can also be interpreted as a strategic decision variable of the innovator, see *Yiannaka*, *Fulton* (2006).

assume that the protected product space is situated symmetrically around the location of the patentee's product. As we set $x_\nu = 0$, this point on the circle defines the middle of the protected product space, see Figure 1. From there patent protection covers $\beta/2$ of the neighboring product space on either side of the innovation.

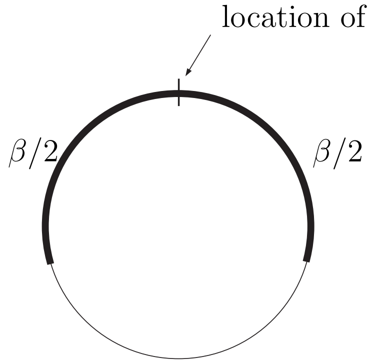


Figure 1: Patent breadth

On the second stage potential rivals simultaneously decide whether to enter the new market, given the patenting decision of the innovator, $\sigma_n^2 = \{\text{entry, no entry}\}$.
Upon entry all firms face market entry costs. These can be understood as the costs necessary to complete the research projects the firms were engaged in earlier, as they participated in the ex-ante innovation race. By investing the fixed costs of market entry, firms can achieve the capability to produce a variant of the new product. If the innovator decides to patent his discovery, according to patent law he is required to disclose sufficient information so that anyone *skilled in the art* is able to reproduce the patented product. Although competitors are not allowed to enter the market with an exact imitation of the protected product, they have the possibility to invent around the patent as long as patent breadth does not deter entry completely, $\beta < 1$.
If the information included in the patent application is relevant and thus useful for a rival firm, achieving the capability to enter the new market is easier and becomes less costly. To capture this theoretically, we assume that market entry costs decrease by patenting. Denoting market entry costs in the case of secrecy by f_s, in the case of a patent they decrease to f_ϕ with $f_\phi = \alpha f_s$, $0 \leq \alpha \leq 1$, where α is a measure for the extent of the disclosure effect – the lower α, the higher is the disclosure effect. The difference between market entry costs with and without a patent yields the amount of mandatorily

disclosed information, $\Delta f = (1-\alpha)f_s$. We further specify $\alpha \equiv 1 - e\rho$ as we propose that the strength of the disclosure effect is driven by two exogenous parameters: the national implementation of a research use exemption, e, $0 \leq e \leq 1$, which is generally defined by patent law and the legal practice in a respective country, and a market specific parameter ρ, $0 \leq \rho \leq 1$ which reflects the fact that the relevancy and usefulness of the disclosed information for competitors is contingent on the respective market. While it may well be that competitors very intensively profit from the disclosed information (ρ is high), it could also be that the opposite is the case and the information is useless (ρ is low).[5] For a given implementation of the research use exemption, $\bar{e}$, a higher relevancy of the patented matter for the competitors' research leads to a stronger disclosure effect.
Naturally both effects influence each other. Whenever both reach their maximum, the disclosure effect reaches its maximum, so that $f_\phi = 0$. If either parameter is set to zero, the disclosure effect is absent, $f_\phi = f_s$, i.e. if the disclosed information is irrelevant for competitors, disclosure has no effect on their market entry costs.[6]

Concerning the location of firms, we will use the well established principle of maximum differentiation: Firms will locate as far away from each other as possible to soften price competition.[7] If secrecy prevails firms will locate equidistantly with distance $1/N^s$ on the unit circle, where N^s is the number of firms operating in the market with secrecy. With a patent the non-patentee firms can no longer freely locate on the unit circle. Still, they will try to move as close as possible to their profit maximizing, equidistant locations. Consequently, in the case of a patent, when the choice of location is restricted to the product space $1-\beta$, the direct neighbors of the patentee will locate at the borders of the patent and all other entrants will locate equidistantly between them.
On the third stage all firms in the new market compete in prices, $\sigma^3_{\nu,N} = p$.

[5]This interpretation of ρ is related to the term "appropriability" that *Kamien*, *Zang* (2000) used for the capability of firms to appropriate the unintended R&D spillover flows from competing firms. While firms in their setting are able to endogenously determine their ability to appropriate in our model "relevancy" is a purely exogenous variable which is subject to the respective market for the innovation.

[6]To our best knowledge all developed countries at least to some extent exhibit a legal research use exemption so that the parameter e actually always has a positive value, i.e. a disclosure effect exists.

[7]*Kats* (1995) shows that this principle leads to a subgame perfect Nash equilibrium in a location then price game in a circular market.

2.1 Price Competition

To find the subgame perfect Nash equilibrium, we solve the game by backward induction, setting off with the last stage. Here we have to distinguish the cases:

(i) the innovator has not patented, $\sigma_\nu^1 = \{s\}$,

(ii) the innovator has patented $\sigma_\nu^1 = \{\phi\}$

We will consider the cases subsequently, starting with case (i).

(i) the innovator has not patented $\sigma_\nu^1 = \{s\}$

In the case that the innovator refrains from patenting and chooses secrecy to protect his innovation, our model simplifies to the well known *Salop* (1979) model of a circular city which we will briefly analyze in the following: All firms are symmetric so that it suffices to analyze the decision of one representative firm denoted by k. With moderate market entry costs, every consumer in the non-protected market buys one unit of the differentiated product from the firm that offers the variant which is closest to his preferences.[8]
Standard computations then yield equilibrium prices,

$$p^* = 1/(N^s)^2, \tag{1}$$

and profits

$$\pi_n^* = 1/(N^s)^3 - f_s \tag{2}$$

for the N^s entering firms. Note that the profit of the innovator amounts to

$$\pi_\nu^* = 1/(N^s)^3 \tag{3}$$

as he does not face market entry costs.

(ii) the innovator has patented $\sigma_\nu^1 = \{\phi\}$

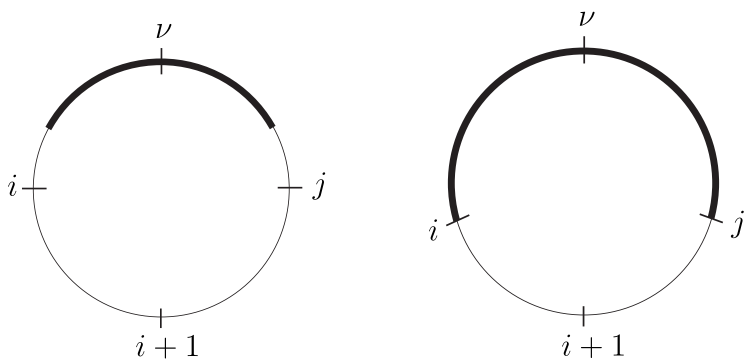
Now let us turn to case (ii) and look at the situation when the innovator decides to protect the new product by a patent. As long as the breadth of the patent is rather moderate, $\beta/2 < 1/N^s$, the patent does not influence the location of rival firms and the symmetric result derived above emerges. Note though, that market entry costs decrease subject to the disclosure effect

[8] In this paper we exclude the monopoly case. See *Zaby* (2010) for an extensive analysis of this issue.

in the respective market. If either the non-patentee firms are able to use the disclosed information to a rather large extent (ρ is high), and/or the respective country broadly implemented a research use exemption (e is high), more firms than in the case with secrecy might enter the market so that $N^{\phi} > N^{s}$. To start with, we will exclude this possibility and assume that the number of firms is left unchanged by a patent, $N^{\phi} = N^{s}$. If the protectional degree of the patent is high,

$$\beta \geq \beta^{\text{res}} \equiv \frac{2}{N^{s}}, \tag{4}$$

equidistant locations on the entire circumference of the circle are no longer possible as the patent restricts the locations for entering firms to the product space $1 - \beta$. We will define patents in a setting where patent breadth, β, fulfills condition (4) as *restrictive* patents. The following figure depicts firms' locations with $N^{\phi} = 4$ for the cases (a) that the patent is not restrictive ($\beta < 1/2$), and (b) that the patent is restrictive ($\beta \geq 1/2$).



(a) non-restrictive patent (b) restrictive patent

Figure 2: Firms' locations with a patent, $N^{\phi} = 4$

In the case that the innovator has patented, firms' neighborhoods are no longer uniform, but are dependent on the respective location of a firm. To distinguish firms' locations we will refer to the left and right neighbor of the innovator as firms i and j. Further we will denote the first right (left) neighbor of i (j) by $i+1$ ($j+1$), the second by $i+2$ ($j+2$) and so on. Consequently, with a restrictive patent an equilibrium can no longer be derived by analyzing a representative firm, as the respective neighborhood of a firm now plays a crucial role for its pricing decision. We have to distinguish three types of firms, differing by their respective neighborhood:

a) the patentee has a uniform neighborhood consisting of firms i and j

b) the „border“ firms i and j have a non-uniform neighborhood with the patentee on the one side and either each other or, if $n > 2$, a non-patentee, non-border firm $i+1$ or $j+1$ on the other side

c) a non-patentee, non-border firm $i+\kappa$, $\kappa \geq 1$ always has a non-uniform neighborhood ($i+\kappa-1$ to the left, $i+\kappa+1$ to the right side) as long as it is not the firm with the greatest distance to the patentee.[9]

As we are analyzing the last stage of the game we take the number of firms that have entered the market as given. Due to the fact that the neighborhood of every firm is crucial for its individual demand and thus pricing decision, we will have to distinguish the indifferent consumer between every pair of firms, say y and z. From the viewpoint of firm y the indifferent consumer will be denoted by $\hat{x}_{y,z}$, from the viewpoint of its neighbor z it will be denoted by $\hat{x}_{z,y}$. By standard computations the location of the indifferent consumer can be found by equating the respective utilities a consumer realizes by buying from either of its neighboring firms.

Given the indifferent consumer the demand and the price reaction functions of the respective firm types can be derived. For an extensive elaboration on this see *Zaby* (2010).

2.2 Market Entry

The analysis of the market entry decisions again needs to distinguish the cases (i) the innovator has not patented and (ii) the innovator has patented. It is crucial for our analysis of the impact of a research use exemption on the propensity to patent that even if the innovator patents, competitors have the possibility to enter the market by inventing around the patent. As market entry costs decrease subject to the strength of the disclosure effect it might be that more firms are able to enter with patent protection than with secrecy.

[9]For this firm we need to distinguish two cases that depend on the number of non-patentee firms n

- if n is even, which we will denote by n^e, then the firm furthest away from the patentee is firm $i+(n^e/2-1)$ and its neighborhood is non-uniform: to the left firm $i+(n^e/2-2)$, to the right firm $j+(n^e/2-1)$
- if n is uneven, n^u, then the firm furthest away is firm $i+(n^u-1)/2$ and its neighborhood is uniform: to the left firm $i+(n^u-3)/2$, to the right firm $j+(n^u-3)/2$.

(i) the innovator has not patented $\sigma_\nu^1 = \{s\}$

Whenever the innovator decides to keep his discovery secret the analysis of the market entry decisions of his rivals corresponds to the well known Salop result: the number of firms entering the market can be derived by solving the zero-profit condition $\pi_n^s = 0$ of a representative firm for n. Using (2) we get

$$(n^s)^0 = (1/f_s)^{1/3} - 1. \tag{5}$$

(ii) the innovator has patented $\sigma_\nu^1 = \{\phi\}$

If we turn to case (ii) and assume that the innovator has patented his innovation on the first stage of the game, we can no longer pin down the market entry decisions in one zero-profit condition. Due to the asymmetric neighborhoods of firms the analysis of market entry becomes more complex. In the following we will briefly outline the derivation of the critical thresholds of market entry costs f_ϕ that yield varying market structures.[10] As the patentee always operates in the market himself the total number of firms consists of him and the number of entering firms. In the case that the innovator has patented we denote the entering rival firms by n^ϕ so that $N^\phi = n^\phi + 1$. To ease notation we simply use the respective number of firms operating in the market as subscript, so e.g. the subscript 4 stands for the case $N^\phi = 4$ and $\pi_{\nu,4}$ denotes the profit of the patentee in the case that 4 firms operate in the market.

For a sufficient definition of the number of entering competitors an upper and a lower bound for market entry costs have to be defined. We denote the upper bound of a market structure with N firms as f_N. This means that for market entry costs $f_N \geq f$ at least N firms are able to enter. The exact number can be defined by additionally defining a lower boundary assuring that no more than N firms can enter. We refer to this critical threshold as f_{N+1}. Obviously the potential entrant(s) with the lowest profits is (are) decisive for this threshold. Whenever profits decrease due to higher market entry costs his (their) profit(s) will be the first to become negative. Following economic intuition the firm(s) with the lowest profit(s) must be the firm(s) located at the furthest distance to the patentee. This is due to the following fact: The border firms i and j are able to set the highest prices of all non-patentee firms, as they face a relatively large mass of consumers situated between

[10]The analysis of the cases $N^\phi < 4$ can be found in *Zaby* (2010). They reveal some special issues which are not essential for the qualitative results concerning the impact of the research use exemption on the propensity to patent, so we omit these cases here.

themselves and the patentee. This positive price effect of patent protection is passed on to every other neighbor, but it gets weaker the further away from the patentee a firm is located.
Whenever the number of entering firms, n^{ϕ}, is even, all rivals have a semi-symmetric partner and thus the profits of the two firms located at the greatest distance to the patentee define the lower bound of market entry costs. Whenever the number of entering firms is uneven, the firm located furthest away from the patentee has no semi-symmetric partner and thus the lower bound of market entry costs is given by its profits.
Given both boundaries for market entry costs the number of entering firms in general is sufficiently defined by

$$f_N \geq f > f_{N+1}\,. \tag{6}$$

The derivation of the critical boundaries is in detail described in *Zaby* (2010).

2.3 The Patenting Decision

On the first stage of the three-stage game the innovator decides whether to patent his innovation or to keep it secret, $\sigma_{\nu}^{1} = \{\phi, s\}$. His patenting decision is driven by two opposing effects. On the one hand a patent protects part of the market, β, from the entrance of rival firms. We refer to this as the *protective effect* of patenting. On the other hand the patentee faces the consequences from the disclosure requirement linked to a patent. In combination with the implemented research use exemption and the relevancy of the disclosed information for competitors the disclosure effect might lead to decreasing market entry costs. This may possibly make market entry profitable for a larger number of firms than with secrecy. Recall that we defined the reduction of market entry costs as $\Delta f = (1-\alpha)f_s$.
In the following we need to distinguish two cases: (i) the disclosure effect is so high (i.e. α is so low) that the competitors are able to legally use a substantial part of the disclosed information and (ii) the disclosure effect is rather weak (i.e. α is high) due to the fact that the research use exemption is implemented narrowly and/or the relevancy of the disclosed information is low. In case (i) the strong disclosure effect leads to a major reduction of market entry costs and thus enables more firms to enter the market whenever the initial innovation is patented so that $N^{\phi} > N^{s}$. Obviously the research use exemption from patent infringement has an impact on the propensity to patent in this case. Technically speaking, the number of firms which are able to enter increases whenever market entry costs decrease below the critical threshold f_{N+1}, see Equation (6). Thus more firms will be able to

enter due to patenting whenever $f_\phi = \alpha f_s < f_{N+1}$. Rearranging we get a critical condition for the strength of the disclosure effect, $\alpha < f_{N+1}/f_s$, which defines whether the disclosure effect has an impact on the market structure or not. Defining $\alpha^N \equiv f_{N+1}/f_s$ we can state that whenever $\alpha^N > \alpha \geq 0$ the research use exemption has an impact on the propensity to patent as the disclosure effect enables more firms to enter the market. In case (ii) a weak disclosure effect leads to an only minor reduction of market entry costs so that $N^\phi = N^s$. Technically speaking, the research use exemption has no impact whenever $1 \geq \alpha \geq \alpha^N$.
Figure 3 illustrates the critical thresholds of market entry costs for alternative levels of patent breadth, β, where the solid lines depict the critical thresholds for the case that the innovator chooses secrecy and the dashed lines depict the critical thresholds for the case that the innovator patents.[11]

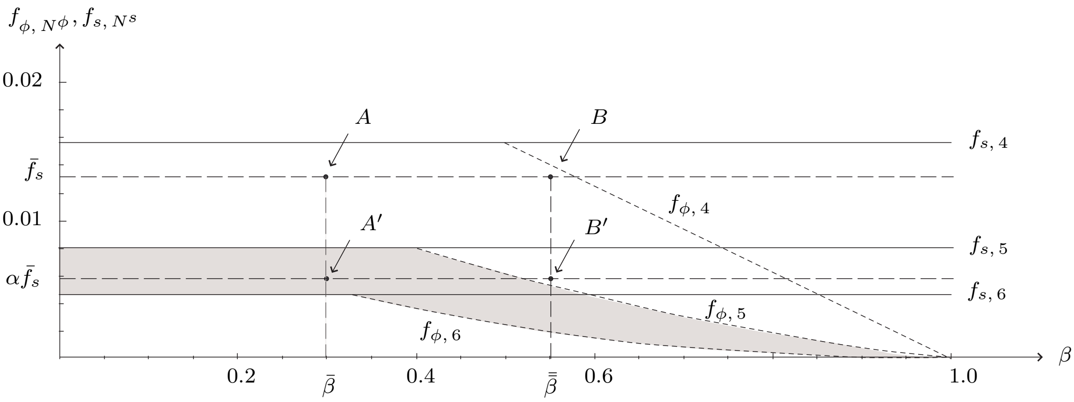


Figure 3: Critical thresholds of market entry costs

Obviously the curves f_{ϕ,N^ϕ} and f_{s,N^s} are equal up to the point where patent protection becomes restrictive, $\beta \geq 2/N^s$. All combinations of f and β that lie between two curves f_N and f_{N+1} lead to a situation where N firms enter the market. Thus in the shaded area in Figure 3, $N^\phi = 5$ firms would enter the market with a patent while with secrecy $N^s \geq 5$ could enter in this area. Obviously, given market entry costs and patent breadth, a patent may lead to two different cases:[12]

[11] Note that to maintain clarity we omitted f_{s,N^s} for $N^s > 6$. These curves would be located below $f_{s,6}$.

[12] In fact, a third case where due to a dominant protective effect less firms enter with a patent may prevail, see *Zaby* (2010) for details.

(a) due to a dominant disclosure effect more firms are able to enter with a patent, i.e. the research use exemption has an impact on the market structure;

(b) due to a dominant protective effect the number of firms is not changed by patenting, i.e. the research use exemption has no impact on the market structure.

Take for example the case where patent breadth is rather low, $\bar{\beta}$, and thus the protective effect is only moderate. Given market entry costs, $\bar{f}_s$, we are at point A where $N^s = 4$. By patenting the disclosure effect reduces market entry costs to $\alpha\bar{f}_s$. In this example case the research use exemption has an impact as by patenting we move to point A' where $N^\phi = 5$ firms are able to enter (case (a)). Keeping the strength of the disclosure effect fixed and increasing patent breadth to $\bar{\bar{\beta}}$, we are at point B where again $N^s = 4$ firms can enter with secrecy. By patenting market entry costs are reduced by the same amount as before so we move to point B'. In this case the research use exemption has no impact as with $N^\phi = 4$ firms entering the market structure is left unaffected by patenting. Consequently, opposing the case with a low protective effect due to a low β, a strong protective effect may overcompensate the impact of the research use exemption (case (b)).
To find out whether the innovator will choose to patent or to keep his innovation secret in the cases considered above, we need to compare the respective profits he can realize given the alternative combinations of market entry costs and patent breadth. In the following figure the profits of the innovator subject to f and β are plotted for the cases that he chooses a patent (dashed lines) or secrecy (solid lines).

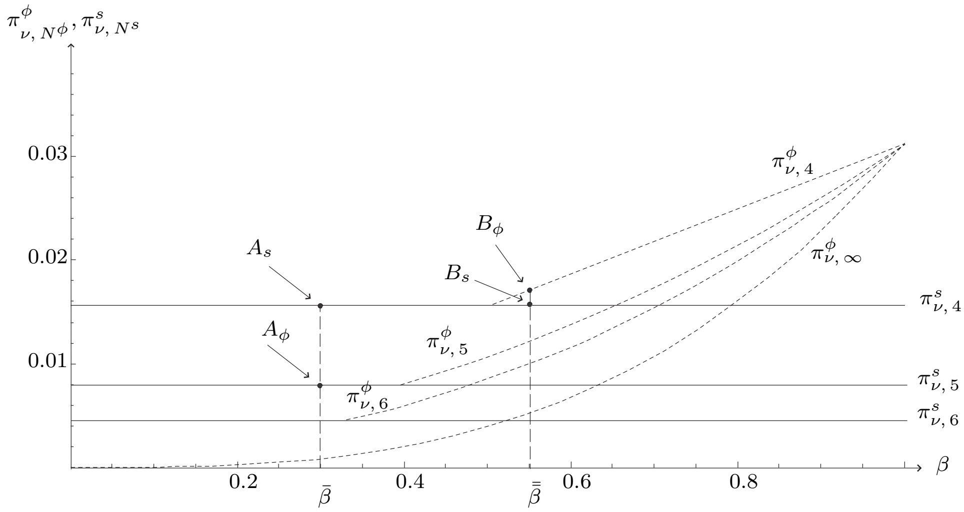


Figure 4: Alternative profits of the innovator with a patent/secrecy

Let us start with the analysis of case (a) where more firms are able to enter due to a patent. In our example case with moderate patent breadth, $\bar{\beta}$, we need to compare the profits A_s and A_ϕ. Obviously the innovator is better off with secrecy in this case, as then he realizes higher profits, $\pi^{s}_{\nu,4}(\bar{\beta}) > \pi^{\phi}_{\nu,5}(\bar{\beta})$. Things change in case (b) where we assumed a higher patent breadth, $\bar{\bar{\beta}}$. Here we have $N^s = N^\phi = 4$. Comparing the profits at points B_ϕ and B_s shows that in this case the innovator is better off with a patent, as this yields higher profits, $\pi^{\phi}_{\nu,4}(\bar{\bar{\beta}}) > \pi^{s}_{\nu,4}(\bar{\bar{\beta}})$.

The following Proposition summarizes our results so far.

Proposition 1 *Whenever the research use exemption has no impact,* $1 \geq \alpha \geq \alpha^N$, *so that* $N^s \geq N^\phi$, *the innovator's protection decision depends solely on the protective effect of a patent. If*

- *(i)* $\beta \leq 2/N^s$ *the protective effect is low and the innovator always prefers secrecy*
- *(ii)* $\beta > 2/N^s$ *the protective effect is high and the innovator always prefers to patent.*

The above Proposition covers the situation where the research use exemption has no impact, which leaves us to analyze the case where due to the required disclosure of the innovation and the relevancy of this information for competitors, more firms are able to enter the market with a patent, $N^\phi > N^s$

(case (a)). Again using Figure 4 it is easy to see that if the disclosure effect is so substantial that the number of firms in the market increases by patenting, it is nevertheless subject to patent breadth whether the innovator is better off with a patent.
Obviously the patent profit functions $\pi^{\phi}_{\nu, N^{\phi}}$ for $N^{\phi} > 4$ cross at least one secrecy profit function π^{ϕ}_{ν, N^s} with $N^{\phi} > N^s$. We will refer to the intersection point as $\hat{\beta}_{N^s, N^{\phi}}$. As the patent profit functions are increasing in patent breadth, the innovator will prefer secrecy for relatively low values of patent breadth, $\beta \leq \hat{\beta}_{N^s, N^{\phi}}$, and he will prefer to patent for relatively high values of patent breadth, $\beta > \hat{\beta}_{N^s, N^{\phi}}$. Take for example the situation where with secrecy 4 firms would enter the market and with a patent 6 firms could enter due to the market entry costs reduction imposed by the disclosure requirement. The relevant intersection point in this case is $\hat{\beta}_{4, 6}$. Whenever patent breadth is lower than $\hat{\beta}_{4, 6}$ the protective effect of the patent is too weak to overcompensate the negative disclosure effect and the innovator will prefer secrecy as this yields higher profits. If patent breadth exceeds the critical threshold, the protective effect overcompensates the disclosure effect and the innovator is better off with a patent. Generalizing these results we come to our next Proposition.

Proposition 2 *Whenever the research use exemption has an impact, $\alpha^N > \alpha \geq 0$, so that $N^{\phi} > N^s$, the innovator will*

- *(i) prefer secrecy for all $\beta \leq \hat{\beta}_{N^s, N^{\phi}}$,*
- *(ii) prefer to patent if and only if patent breadth exceeds a critical threshold $\beta > \hat{\beta}_{N^s, N^{\phi}}$.*

A comparison of the critical thresholds for patenting in the theoretically alternative cases of Proposition 1 and 2 leads us to

Corollary 1 *The propensity to patent is higher whenever the impact of a research use exemption is weak.*

Whenever the innovator's competitors do not want to use the disclosed information due to its minor relevancy, the negative disclosure effect is mitigated and the existence of a research use exemption has no impact on the propensity to patent. If the disclosed information becomes more profitable for competitors the research use exemption has an impact on the propensity to patent: Due to a strong disclosure effect it decreases.

Note that the introduction of a research use exemption would have the same effects as moving from a scenario where the research use exemption has a weak impact on the propensity to patent to a scenario where it has a strong impact. This enables us to relate the finding stated in the above Corollary to the ongoing discussion of implementing a statutory research use exemption in several countries. Although the implementation of a research use exemption may spur technological progress by simplifying the research of follow-on inventors (see e.g. *Nagaoka*, *Aoki* (2009) for an economic analysis that comes to this conclusion), at the same time it may lead to a substantial decrease of the propensity to patent. Therefore it could be that the overall effect of introducing a research use exemption yields a negative effect on technological progress.

3 Empirical Investigation

Summarizing, the theoretical analysis comes to the conclusion that when a statutory research use exemption is in place ($\bar{e} > 0$), an innovator's decision between a patent and secrecy is mainly driven by two factors: the relevancy of the disclosed information for competitors, ρ, and initial market entry costs f_s. A variation of these factors may intensify the disclosure effect and may thereby lead to a decreasing propensity to patent.

Recall that we defined $\alpha \equiv 1 - e\rho$ as the measure decisive for the extent of the disclosure effect. As the respective national implementation of a research use exemption is the same for all firms operating in the same country, it is the market-specific variation of the relevancy of the disclosed information, ρ, which drives the extent of the disclosure effect. The more intensively competitors benefit from the information disclosed in the patent application, i.e. the higher ρ, the higher is the extent of the disclosure effect, i.e. the lower is α. This effect leads to a change in market entry costs for the patentee's rivals by the amount $\Delta f \equiv f_s - \alpha f_s$. According to Propositions 1 and 2 the propensity to patent is higher, the lower this disclosure effect is. Inserting our definition of α into the term Δf we have $\Delta f = \bar{e}\rho f_s$. Consequently, we can pin down the effectiveness of the disclosure effect as the negative impact of the combined effect ρf_s on the propensity to patent as $\bar{e}$ is the same for all firms in the respective country.

The first of these parameters, the relevancy of the disclosed information ρ, in theoretical terms is always linked to the height of initial market entry costs, f_s. Whenever ρ increases, market entry costs in the case of a patent decrease, $\partial f_\phi / \partial \rho < 0$. This in turn leads to an increasing number of firms that are able to enter the market despite a patent. This negative effect of patenting

then leads to a decreasing propensity to patent.
The second parameter, initial market entry costs, f_s, has countervailing effects on the propensity to patent. Additionally to the combined effect, ρf_s, the theoretical model identified the following further effects: One clearly is in line with economic intuition as it stems from the fact that increasing market entry costs form a natural barrier to entry, so that patenting, i.e. establishing own, costly entry barriers, becomes obsolete. In terms of the theoretical model, increasing market entry costs lead to an increase of the critical threshold for a restrictive patent, β^{res}. This means that the minimum strength of protection which would induce a positive protective effect for the innovator increases. As a consequence the parameter space of patent breadth, β, where patenting potentially leads to a protective effect which can overcompensate the possible negative effect from mandatory disclosure, becomes narrower. Through this mechanism increasing market entry costs weaken the protective effect and thereby have a negative effect on the propensity to patent. Besides this weakening impact on the protective effect, increasing market entry costs also mitigate the disclosure effect and thus positively influence the propensity to patent. This effect evolves from the critical threshold concerning the impact of the disclosure effect, $\alpha^N \equiv f_{N+1}/f_s$. As α^N decreases whenever initial market entry costs increase, the parameter space where the disclosure effect has no impact on the resulting market structure grows larger and thus the propensity to patent increases.

Before we proceed with the empirical investigation it should be noted that a basic difference between the theoretical and the empirical analysis is the fact that in the theoretical model the cases where either the disclosure effect has a strong or a weak impact were excluding cases. Naturally in reality both cases prevail at the same time. Given the national implementation of a research use exemption in a country, in some markets the relevancy of the disclosed information may be higher than in others. Due to this firms face differing impacts of the research use exemption depending on the usability of the disclosed information in their respective market.
The empirical analysis proceeds with the deduction of two hypotheses from the theoretical model in Section 3.1. Subsequently we will turn to the definition of our data sample and the implementation of the variables in Section 3.2 before we turn to our empirical results in Section 3.3.

3.1 Hypotheses and their Empirical Implementation

As pointed out above, the theoretical model identifies two main parameters as crucial for the propensity to patent: the relevancy of the disclosed information

for competitors, ρ, and initial market entry costs f_s. In the above summary the influence of increasing market entry costs on the propensity to patent was divided into countervailing effects.
The theoretical model does not allow for a conclusion on which of the effects of market entry costs is strongest. Nevertheless, to formulate an adequate hypothesis we need to commit ourselves to one of the possible scenarios. Following economic intuition we propose that increasing market entry costs, as they form a natural barrier to market entry, lead to a decreasing propensity to patent. This leads to the following Hypothesis.

Hypothesis 1 *The propensity to patent decreases when market entry costs increase.*

Note that the above Hypothesis proposes that the weakening effect of market entry costs on the protective effect even overcompensates the combined effect ρf_s, which captures the impact of the research use exemption on the propensity to patent. Whenever the relevancy parameter is low, the negative effect of the required disclosure is mitigated as the revealed information is nearly useless for the innovator's competitors. In this case, due to their respective competitive environment, competitors are not able to use the disclosed information, i.e. by patenting their market entry costs are only slightly reduced. This low impact of the research use exemption obviously has a positive effect on the propensity to patent. Whenever the relevancy parameter is high, patenting has a strong negative effect, as the mandatorily disclosed information has a high relevancy for the research activities of competitors, i.e. market entry costs are strongly reduced so that market entry becomes profitable for more firms. Summarizing we can state that a decreasing relevancy - by weakening the impact of the research use exemption - has a positive effect on the propensity to patent. This gives us the second hypothesis.

Hypothesis 2 *Whenever the impact of the research use exemption decreases, the propensity to patent increases.*

We translate these theoretical results into the following empirical equation:

$$P = \beta_0 + \beta_1 MEC + \beta_2 REL + \beta_3 REL * MEC + Controls + \epsilon,$$

where P denotes the patenting decision, MEC are the initial costs of market entry, and REL reflects the relevancy of the disclosed information for the patentee's competitors.
To capture the disclosure effect in empirical terms we include the combined effect $REL * MEC$, as the theoretical model proposes that this term reflects the impact of the research use exemption on the propensity to patent.

In the previous section we extensively discussed that we expect the single effect of MEC to be negative: as initial market entry costs rise, the barriers to entry increase so that the usefulness of a patent diminishes, resulting in a decrease of the propensity to patent. However, the interaction term with relevancy, $REL * MEC$, which reflects the disclosure effect, should reveal a negative effect on patenting.

3.2 Sample and Variable Definition

The basis for our empirical analysis is the Mannheim Innovation Panel (MIP) of the year 2005 consisting of about 5,000 surveyed German firms. The MIP is an annual survey which is conducted by the Centre for European Economic Research (ZEW) Mannheim on behalf of the German Federal Ministry of Education and Research initiated in the year 1992. The aim of the survey is to provide a tool to investigate the innovation behavior of German manufacturing and service firms. Regularly – currently every two years – the MIP is the German contribution to the Community Innovation Survey (CIS). In the year 2005, the survey contained additional questions concerning the firm's perception of their competitive situation with respect to competitive factors like price or quality as well as the perceived competitive situation regarding the number of competitors and their relative size.
A central assumption to our theoretical analysis is that the successful inventor commercializes his invention immediately, thereby opening a new market. To implement this in empirical terms, we restrict our data to firms which indicate that their innovation activities resulted in the establishment of new markets. Further we only include innovating firms. Hence, considering all theoretical assumptions our empirical investigation is based on a sample of 831 firms.
In the restricted data set we have about 45% of firms indicating that they applied for a patent in the considered time period of the years 2002 to 2004. To capture the relevancy of the disclosed information for competitors, REL, we use a proxy reflecting the easiness of substitutability of own products by products of competitors in the main product market. Whenever firms indicate that they agree or even strongly agree that their own product can easily be substituted competitors' products, the proxy REL has unit value. Descriptive statistics reveal that nearly 70% of firms find that their competitive environment is characterized by easy to substitute products. A further crucial parameter of the theoretical model are market entry costs which are not straightforward to implement empirically. In default of a corresponding measure in the MIP 2005, we refer to a firm's perception on whether its market position is threatened by the entry of new rivals as a proxy for initial market entry costs, MEC. We define this proxy to take unit value whenever

a firm perceives its market position as hardly or weakly threatened by the market entry of competitors, indicating that initial market entry costs are high. This is found relevant by almost 90% of the sampled firms.

Table 1: Descriptive Statistics

	Mean	**Std. Dev.**	**Min**	**Max**
patent	0.442	0.497	0	1
market entry costs	0.895	0.306	0	1
relevancy	0.687	0.464	0	1
*REL * MEC*	0.603	0.490	0	1
large number of firms	0.158	0.365	0	1
log(employees)	4.305	1.673	0	9.077
human capital	0.243	0.255	0.000	1.000
R&D intensity	0.065	0.273	0.000	6.427
capital intensity	0.109	0.272	0.000	4.554
EU	0.584	0.493	0	1
non_EU	0.409	0.492	0	1
customer power	0.300	0.458	0	1
cooperation	0.368	0.483	0	1
east	0.321	0.467	0	1
No. of observation		831		

As described above we include the interaction term $REL * MEC$, which reflects the perceived market entry costs if the relevancy of the disclosed information for the competitors for a given level of the research use exemption is high. This is relevant for 60% of firms.

Furthermore, we control for several factors that may influence the decision to patent. To reflect the influence of the number of competitors the patentee faces, we use a categorical variable provided my the MIP displaying the ranges of the number of competitors as perceived by a firm.[13] We use a dummy variable *large number of firms* which indicates that a respondent firm has more than 15 competitors. In our data set this is the case for 16% of all firms. Firm size is represented by the number of *employees* in the year

[13]The ranges are defined as follows: *no competitors*, *1 to 5 competitors*, *6 to 15 competitors* and *more than 15 competitors*.

2002, *human capital* by the lagged share of employees holding a university degree. In order to capture whether the main market is characterized by specific market entry barriers, we control for *capital intensity* defined as tangible assets per employee. Furthermore, as R&D is viewed as a crucial input for potentially patentable innovation activities we control for *R&D intensity* defined as expenditures for in-house R&D activities per sales.[14] If firms cooperate with others, e.g. competitors, customers, universities, in conducting R&D this may influence their IP protection strategy. Therefore we include a dummy variable reflecting whether research cooperations take place. In order to capture regional and sectoral differences we include an indicator whether the firm is located in eastern Germany (*east*) and define 11 *industry dummies*. *Customer power* refers to the fact that the share of sales by the three most important customers exceeds 50% of total sales. Finally we describe the competitive situation with respect to the geographical dimension of the product market. We control for two world regions, the *EU* and *non-EU*. Germany, i.e. the local, regional and national markets, is considered separately as it serves as reference category in the regression. Thus it is not contained in the variable *EU*.

3.3 Empirical Results

To test the influence of a varying impact of the disclosure effect, which the theoretical model identified as the combined effect of the relevancy of the disclosed information for competitors and initial market entry costs, on the propensity to patent we estimate a probit model and calculate marginal effects evaluated at the sample means. The marginal effect of the interaction term is calculated according to *Cornelißen*, *Sonderhof* (2009). Results are presented in Table 2.

According to our first Hypothesis an increase of market entry costs should result in a lower probability to patent. The result of the empirical estimation reveal that the opposite effect prevails: we find a positive relation between market entry costs and the propensity to patent so that Hypothesis 1 is rejected. This result at first sight contradicts economic intuition. As pointed out earlier the theoretical model proposes countervailing effects of market entry costs on the propensity to patent. The empirical estimation now allows us to draw a conclusion about which of the effects is strongest. Since we find a positively significant total effect, the mitigating impact of initial market entry costs on the disclosure effect obviously overcompensates the other negative

[14] Note that while capital intensity is taken from the year 2002 due to the lack of adequate data we could not use a lagged instrument variable for R&D expenditures. We try to mitigate the resulting problem of endogeneity by instead using R&D activities per sales.

effects. Thus, by reducing the critical threshold, α^N, and thereby increasing the parameter space in which the disclosure effect has no impact on the resulting market structure, increasing market entry costs lead to a rising propensity to patent. This points to the fact that actually market entry costs do not form a sufficiently strong natural barrier to entry so that even with high market entry costs patenting does not become obsolete.

Concerning the combined effect of market entry costs and the relevancy of the disclosed information for the competitors, $REL * MEC$, we find a negative marginal effect. This confirms our second Hypothesis.[15] The interpretation is quite straightforward. Recall from the theoretical model how αf_s drives the negative effect of patenting, i.e. the loss of information. With secrecy, market entry costs are given by f_s, by patenting they are reduced to $f_\phi \equiv \alpha f_s$. Recall from above that the disclosed information amounts to $\Delta f = f_s - \alpha f_s = \bar{e}\rho f_s$. Hence, in a country with a broadly implemented research use exemption, i.e. with a high $\bar{e}$, the combination of a high relevancy of the disclosed information, ρ, and increasing market entry costs, f_s, increase the change in market entry costs, Δf, so that patenting reduces firms' propensity to patent.

Concerning our control variables we find that larger firms, firms with an increasing percentage of highly qualified employees, firms with an increasing R&D intensity and firms with R&D cooperations have a higher propensity to patent. Contrasting this, firms located in the Eastern part of Germany have a lower probability to patent. Finally, firms mainly competing with enterprizes outside Europe have a higher propensity to patent. As we can only observe that firms have filed a patent but not where they filed it, there may be two explanations for this finding. On the one hand it may be that these firms file patents at their domestic patent office (i.e. the German or European Patent Office) in order to secure their domestic markets from the entry of foreign competitors. On the other hand, it may be that these firms file their patents in their main competitors' countries in order to secure their own market entry. Both effects may exist at the same time. This reasoning does not contradict the non-significant effect of a main competitors' base in the EU. The EU tries to establish a harmonization of the member countries' patent laws which is not yet accomplished but is already in progress. As a result, there is de facto no difference between the German and the European product market with respect to patent protection.

[15] As the interaction term considers the industry-specific relevancy of the disclosed information for competitors combined with market entry costs but lacks the theoretically introduced extent of the research use exemption, the marginal effect also captures the extent of the German implementation of the research use exemption.

Table 2: Results of the Patenting Decision Estimation

	Marginal Effect	**Standard Error**
relevancy	0.013	0.047
market entry costs	0.140**	0.063
*REL * MEC*	-0.374***	0.147
large number of firms	-0.083	0.062
log(employees)	0.115***	0.016
human capital	0.242**	0.125
R&D intensity	1.458***	0.304
capital intensity	-0.193*	0.113
EU	0.068	0.052
non_EU	0.089*	0.050
customer power	-0.062	0.048
cooperation	0.242***	0.045
east	-0.115**	0.048
industry dummies	*included*	
Log likelihood	-375.10	
McFadden's adjusted R^2	0.342	
$\chi^2(all)$	271.42***	
$\chi^2(ind)$	47.32***	
Number of observations	831	

*** (**, *) 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 that of the interaction term is obtained according to *Cornelißen*, *Sonderhof* (2009). Standard errors are calculated with the delta method.

$\chi^2(all)$ displays a test on the joint significance of all variables.

$\chi^2(ind)$ displays a test on the joint significance of the industry dummies.

4 Concluding Remarks

Our aim was to provide a framework in which the decision of an innovator between a patent and secrecy could be analyzed in the light of a varying impact of a research use exemption from patent infringement. Although a research use exemption from patent infringement is in place for all firms located in a respective country, we argument that the impact of the research use exemption may vary subject to the relevancy of the disclosed information for the patentee's competitors. To capture the positive and negative effects of patenting we introduced the strategic protection decision of an innovator into a model of horizontally differentiated products. As here market entry costs are decisive for the number of firms which are able to enter, the impact of the research use exemption could be substantiated as a decrease of initial market entry costs. Our main theoretical results are: Either the influence of the research use exemption is weak so that if the innovator patents the number of firms able to enter the market is left unchanged, or the impact of the research use exemption is strong so that the number of firms increases if the innovator patents. Whenever the research use exemption has no impact, the patenting decision is solely driven by the protective effect – the broader a patent is, the higher is the innovator's propensity to patent. Other than this, whenever the research use exemption has an impact, we find that the propensity to patent decreases. Although we are not able to investigate the issue of introducing a research exemption in empirical terms due to the lack of data, we can nevertheless state that based on the theoretical model we come to the conclusion that the introduction or extension of a research use exemption might lead to a substantial decrease of the propensity to patent. The empirical investigation of two hypotheses derived from the theoretical model supports our theoretical findings. The existence of a research use exemption from patent infringement has a substantial impact on the propensity to patent. Whenever the negative effect of patenting gains weight due to a high relevancy of the disclosed information for competitors, the existence of a research use exemption decreases the propensity to patent. In empirical terms we captured this by including an interaction term consisting of a measure for the impact of the disclosure effect in the light of a broadly implemented research use exemption and market entry costs. Regarding the overall effect of market entry costs we reject our hypothesis that the prevailing effect of increasing market entry costs on the propensity to patent is negative which would be in line with economic intuition. Our result supports the theoretically derived countervailing effect that increasing market entry costs mitigate the disclosure effect and consequently reduce the parameter space in which the research use exemption has an impact. Hence when the natural barriers to market entry increase, it does not become obsolete to establish own, costly entry barriers and thus the propensity to patent increases. Finally, we can add to the discussion whether a research use exemption is worthwhile to introduce. *Nagaoka*, *Aoki* (2007) find that the establishment of a research use exemption may spur the research of follow-on inventors and hence contributes to the technological progress. We show that a research use exemption deters the propensity to patent and as a consequence may impede technological progress. Which effect prevails is decisive for answering the question to which extent a research use exemption should be implemented and is subject to further research.

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