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The Propensity to Patent with Horizontally Differentiated Products – An Empirical Investigation

Diana Heger
Alexandra K. Zaby

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Diana Heger* and Alexandra K. Zaby†

Abstract

In this paper we empirically investigate the theoretical results obtained in *Zaby* (2009). From the theoretical model, which introduces the decision to patent into a setting with horizontally differentiated products we deduce several hypotheses and test these empirically. We find that the propensity to patent increases when market entry costs decrease. Furthermore, if the disclosure requirement linked to a patent has an impact, the propensity to patent decreases with the strength of the disclosure effect.

Keywords: patenting decision, secrecy, disclosure requirement, market entry, horizontal product differentiation

JEL Classifications: L13, O14, O33, O34

*Centre for European Economic Research, L7, 1, D-68165 Mannheim. E-mail: heger@zew.de

†Universität Tübingen, Wirtschaftswissenschaftliche Fakultät, Mohlstraße 36, D-72074 Tübingen. E-mail: alexandra.zaby@uni-tuebingen.de

1 Introduction

In their seminal empirical study *Cohen et al.* (2000) find that firms do not patent every invention. *Cohen et al.* (2000) isolate the two key reasons for firms not to patent as (*i*) the amount of information disclosed in a patent application and (*ii*) the ease of legally inventing around a patent. Empirical findings of *Arundel* (2001) support these results: Analyzing the relative importance of secrecy versus patents he finds that a higher percentage of firms in all size classes rate secrecy as more valuable than patents.
The aim of this paper is to empirically analyze the influence of the disclosure requirement on the propensity to patent. Naturally the loss of a technological leadership caused by the disclosure of proprietary knowledge will lead the patentee to fear that the transfer of this enabling knowledge may benefit his rivals by facilitating the imitation of the protected invention. In the end this may lead him to refrain from patenting.
The starting point of our empirical investigation is the theoretical model presented in *Zaby* (2009), where the possibility of patenting is introduced into an oligopolistic model of horizontally differentiated products. The main assumptions of the theoretical model are (i) a drastic product innovation is released on a new market where rivals may enter with non-infringing products as patent protection is not perfect; (ii) the strength of patent protection is measured by the *breadth* of a patent (iii) the information revealed due to the disclosure requirement reduces competitor's market entry costs, this facilitates inventing around so that possibly more firms are able to enter the market due to a patent. Thus the positive effect of patent protection may be opposed by the negative effect of the required disclosure.
Zaby (2009) finds two forces which drive the patenting decision: the strength of patent protection and the impact of the disclosure requirement. If the impact of the disclosure requirement is rather weak, the protective effect of the patent is decisive for the innovator's appropriation decision - the broader a patent, the higher is his propensity to patent. If the impact of the disclosure requirement is high, the positive effect of patent protection may be outweighed by the effect of the mandatory disclosure: due to the increasing threat of market entry the innovator will then possibly refrain from patenting.

To implement this model empirically we use information of the Mannheim Innovation Panel (MIP) from the year 2005. The MIP is intended to regularly reflect several characteristics of the innovation activities of German manufacturing and service firms, e.g. R&D and innovation expenditures, as well as IP protection methods. In the year 2005, firms were asked to assess their competitive situation with respect to the characteristics of competition

(price, quality, etc.), as well as with respect to their competitors (number, size, etc.).
We estimate a probit model in order to test the impact of market entry costs and the balancing of the positive and negative effect of patenting on firms' propensity to patent. As the theoretical model predicts different outcomes for the considered cases *the disclosure requirement has no impact* vs. *the disclosure requirement has an impact* we introduce interaction terms of the disclosure requirement indicator with market entry costs as well as with patent breadth, where the latter reflects the positive protective effect of a patent. Our conjectures regarding the signs are in line with the results of the theoretical model.

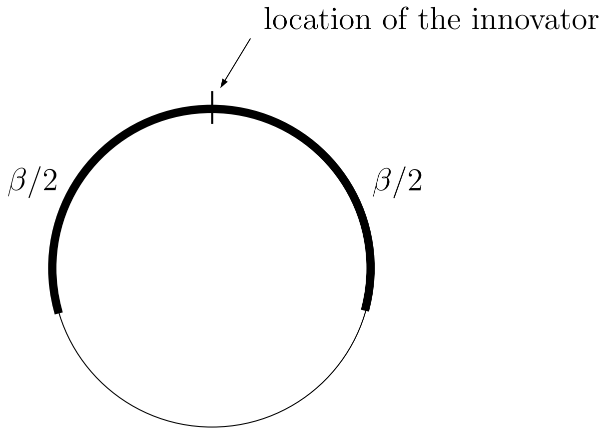
The rest of the paper is organized as follows. The following section gives a brief summary of the theoretical model presented in *Zaby* (2009). In Section 3 we deduce several hypotheses from the theoretical model and present their empirical implementation. The following Section 4 describes the data set and our proceeding in restricting the data sample and defining the variables. Section 5 presents our empirical results and Section 6 concludes.

2 The theoretical model

In this section we will briefly present the basic setup of the theoretical model, especially pointing to aspects central to our empirical implementation. The starting point of the three stage game presented in *Zaby* (2009) is that one firm has successfully accomplished a drastic product innovation and decides to release the new product immediately. As this innovative firm owns the proprietary knowledge concerning the innovation, it will be monopolist in the new market as long as no other firm successfully invents. 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. 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 as long as his net utility is weakly positive.

The structure of the model is as follows: on the first stage of the three-stage game the innovator, already located in the new market, decides whether to patent his innovation or to keep it secret. 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 exogenous. *Zaby* (2009) defines the protected product space as situated symmetrically around the location of the patentee's product, 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



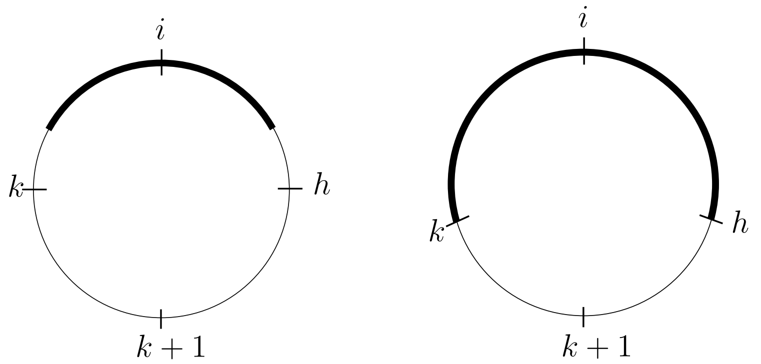
On the second stage n potential rivals, $n \in [0, \infty[$, simultaneously decide whether to enter the new market, given the patenting decision of the innovator. Thus the number of firms operating in the market amounts to $N^u = n+1$, $u = P, S$. Upon entry all firms face market entry costs. These can be understood as the costs necessary to 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 his competitors are not allowed to copy the protected product, they have the possibility to invent around the patent as long as patent breadth does not deter entry completely, $\beta < 1$. Whenever a rival decides to enter the market despite of a patent, he profits from the disclosed information: achieving the capability to enter the new market is now easier and thus less costly. If market entry costs in the case of secrecy amount to f_s, then in the case of a patent they decrease to f_P with $f_P \equiv \alpha f_s$, $0 \leq \alpha \leq 1$, where α is a measure for the impact of the disclosure requirement which may differ subject to specific market conditions. Concerning the location of firms, we will use the well established principle of maximum differentiation meaning that firms will

locate as far away from each other as possible to soften price competition.[1] Thus, if secrecy prevails, firms will locate equidistantly on the unit circle. With a patent potential entrants cannot freely locate on the unit circle due to the range of protected product space. 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.
Note that as long as the breadth of the patent is rather moderate, $\beta/2 < 1/N^P$, the patent does not influence the location of rival firms and the symmetric result emerges. Nevertheless, due to the assumption that the disclosure requirement lowers market entry costs, $f_P < f_s$, more firms than in the case without a patent might enter the market. If the protectional degree of the patent is high,

$$\frac{\beta}{2} \geq \frac{1}{N^P}, \tag{1}$$

equidistant location on the entire circumference of the circle is no longer possible as the patent restricts the locations for entering firms to the product space $1-\beta$. Following *Zaby* (2009) patents in a setting where patent breadth, β, fulfills condition (1) are denoted as *restrictive* patents. The following figure depicts firm's locations with $N^P = 4$ for the cases (a) that the patent is not restrictive ($\beta < 1/2$), and (b) that the patent is restrictive ($\beta \geq 1/2$).

Figure 2: Firm's Locations with a Patent, $N^P = 4$



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

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

On the third stage all firms in the new market compete in prices.

The patenting decision is mainly driven by two factors: On the one hand the fact whether a patent is restrictive or not is crucial for the innovator's appropriation strategy, and on the other hand the impact of the disclosure requirement plays a decisive role. The later depends on the extent to which market entry costs decrease by patenting. Either the influence of the disclosure requirement is such that the number of firms able to enter the market is left unchanged, $N^S = N^p$, or it is such that the number of firms increases, $N^P > N^P$. In the later case a major decrease of market entry costs allows more firms to enter, thus the disclosure requirement has an impact. In the first case - if patenting only leads to a minor (or no) decrease - the number of firms will remain the same independent of the appropriation decision of the innovator, the disclosure requirement has no impact.
The main results of the theoretical model differ subject to the impact of the disclosure requirement: Whenever the disclosure requirement 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 disclosure requirement *has* an impact, *Zaby* (2009) finds that the propensity to patent decreases with the strength of the disclosure effect.

3 Hypotheses and their empirical implementation

In this section we derive hypotheses from the results of the theoretical analysis concerning the propensity to patent with horizontally differentiated products. Our first hypothesis stems from the basic mechanism of the model: the lower the fixed costs of market entry are, the more firms are able to enter the market. As the mandatory disclosure of information can be used by competitors in their attempts to invent around the patent, patenting reduces market entry costs and thus facilitates market entry. Thus we come to the following hypothesis.

Hypothesis 1 *The propensity to patent increases when market entry costs decrease.*

When the initial market entry costs are high, they form an effective barrier to entry. The innovator may thus choose not to patent as then he would face the drawback from the disclosure of information without profiting from the protective effect. If market entry costs decrease, i.e. more firms are able to enter, patenting becomes profitable as it protects at least part of

the product space from the entry of rivals. Consequently the propensity to patent increases when the fixed costs of market entry decrease.
Recall from the theoretical model that the critical threshold for a restrictive patent is $\beta^{crit} = 2/N^s$. Whenever a patent is not restrictive it has no protective effect and is thus not profitable for the innovator. If the disclosure requirement has no impact, which means that the number of competitors will not increase by patenting, every restrictive patent solely has a positive protective effect and the innovator will choose to patent. As $\partial\beta^{crit}/\partial N^s < 0$, the critical threshold for patent breadth decreases as the number of firms in the market rises. This enlarges the range in which a patent is restrictive and consequently the propensity to patent increases. These results can be condensed to the following hypothesis.

Hypothesis 2 *Whenever the disclosure requirement has no impact, the propensity to patent rises with the number of firms operating in the market.*

Due to the impact of the disclosure requirement by patenting market entry costs decrease to $f_P \equiv \alpha f_s$. Thus the change of market entry costs by patenting can be defined as $\Delta_f \equiv (1-\alpha)f_s$. The innovator's profits with a patent are higher, the lower the change of market entry costs, Δ_f, as then less firms are able to enter the market due to the impact of the disclosure requirement. Hence, the decision to patent is crucially influenced by the strength of the disclosure effect.
Market entry costs with a patent (f_P) and with secrecy (f_s) drive this result as follows: On the one hand a rise of f_s results in a higher entry barrier so that patenting becomes obsolete and consequently the propensity to patent decreases. On the other hand the lower the reduction of market entry costs due to patenting, i.e. the higher f_P, the lower is the impact of the disclosure requirement so that patenting becomes more profitable and the propensity to patent rises. Thus, we come to the following hypothesis[2]

Hypothesis 3 *Whenever the disclosure requirement has an impact, the propensity to patent decreases with the strength of the disclosure effect.*

As stated in Hypotheses 2 and 3, the decision to patent is mainly driven by patent breadth (protective effect) and the impact of the disclosure requirement (disclosure effect). The patenting propensity substantially varies subject to the intensity of the disclosure effect. The main result of the model by *Zaby* (2009) is that if the disclosure requirement has no impact, the patenting decision solely depends on the protective effect, i.e. the propensity to

[2]This Hypothesis corresponds to Corollary 1 of the theoretical model.

patent increases with the intensity of patent protection, β (Proposition 1, p. 22). Further, if the disclosure requirement has an impact, the patenting decision depends on the number of firms operating in the market as well as on the extent of patent protection (Proposition 2, p. 23). We translate these theoretical results into the following empirical equation:

$$P = \beta_0 + \beta_1 N * RE + \beta_2 f_s + \beta_3 f_s * RE + \beta_4 N^s + \beta_5 RE + Controls,$$

where P denotes the patenting decision, N the number of firms operating in the market (initial market structure), RE reflects the easiness of substitutability as a proxy for the impact of the disclosure requirement and f_s are the cost of market entry with secrecy.

As elaborated earlier, due to $\partial\beta^{\text{crit}}/\partial N^s < 0$ a change in N is an adequate measure for variations of the critical threshold of patent breadth. If the disclosure effect is low since substitutability is difficult, the driving force behind the decision to patent is the critical threshold of the intensity of patent protection, β^{crit}. The more firms enter, the lower this threshold will be, and thus the higher is the propensity to patent. Thus, following our theoretical results, we expect a positive effect of N on the propensity to patent.

To capture the distinction between the cases *the disclosure requirement has an impact* and *the disclosure requirement has no impact*, we include the interaction terms $N * RE$ and $f_s * RE$. Whenever the dummy variable RE indicating the easiness of substitutability takes the value 0, the disclosure requirement has *no* impact and thus the interaction terms vanish and only the sole effects of N and f_s prevail. Whenever the disclosure requirement *has* an impact, $RE = 1$, the interaction terms additionally influence the sole effects and the overall effect is given by the sum of both effects.[3]

To capture market entry costs (f_s) we use the firms' assessment of the threat of market entry by new competitors. Whenever firms see their market position strongly threatened by market entry, we conjecture that market entry costs are low. According to our theoretical model the single effect of f_s should be negative: as market entry costs with secrecy rise, the barrier to entry increases so that the usefulness of a patent diminishes, resulting in a decrease of the propensity to patent. However, the interaction term with the easiness of substitutability, $f_s * RE$, which reflects the market entry costs of competitors accounting for an impact of the disclosure requirement, should have a positive effect on patenting.

[3] Note that this computation of an overall effect is only feasible if the marginal effects of both variables are significantly distinct from each other.

4 Data set

The basis for the empirical analysis is the Mannheim Innovation Panel (MIP) of the year 2005. The MIP is an annual survey which is conducted by the Centre for European Economic Research (ZEW) Mannheim. 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 of Community Innovation Survey (CIS). Our empirical investigations are based on about 740 firms.

In the year 2005, the survey contained additional questions concerning the firm's perception of the competitive situation. Questions concerning the characteristics and the importance of specific competitive factors like price or quality are asked as well as the perceived competitive situation with respect to the number of competitors and their relative size.

4.1 Sample and Variable Definition

In this section we test the hypotheses derived from the theoretical model reflecting the patenting behavior in a market with horizontally differentiated products. A central assumption to the 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. As before we only include innovating firms.

In the restricted data set we have 45% of firms indicating that they applied for a patent in the considered time period. As stated earlier a variable reflecting the easiness of substitutability is used as a proxy for the impact of the disclosure requirement, RE. Descriptive statistics reveal that nearly 70% of firms find that their competitive environment is characterized by easy to substitute products. The theoretical model finds a critical threshold for patent scope indicating whether a patent has a restricting effect or not. This critical threshold decreases, the more firms operate in the market in the absence of a patent. Naturally it is not straightforward to implement the actual number of firms operating in a market empirically. Nevertheless the MIP provides a categorical variable displaying the ranges of the number of competitors as perceived by a firm.[4] We thus 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.

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

Table 1: Descriptive Statistics for the Patenting Decision Estimation with Horizontally Differentiated Products

	Mean	**Std. Dev.**	**Min**	**Max**
patent	0.442	0.497	0	1
market entry costs	0.105	0.306	0	1
large number of firms	0.158	0.365	0	1
reverse engineering	0.687	0.464	0	1
*MEC * rev. eng.*	0.084	0.278	0	1
*firms * rev. eng.*	0.120	0.326	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

In default of a corresponding measure in 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, f_s. We argument that whenever a firm perceives its market position as strongly threatened by market entry, initial market entry costs, the initial barrier to entry, are low, this is found relevant by 10% of firms.
As described above we include the interaction terms *firms * rev. eng.* and *MEC * rev. eng.* Descriptive statistics show that the first, which captures the change in the number of firms due to the impact of the disclosure requirement, is relevant for 12% of all firms while the latter, which reflects the perceived market entry costs if substitutability plays an important role, is relevant for 8% of firms.
We include *firm size*, *human capital*, *customer power*, the geographical markets *EU* and *non-EU*, *cooperation* and *east* as control variables. For definitions refer to Section **??**, for descriptive statistics see Table 1.

Furthermore, we control for several factors that may influence our dependent variables. Firm size is represented by the number of *employees* in the year 2002, *human capital* by the share of employees holding a university degree. 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 is considered separately as it serves as reference category in the regression. Thus it is not contained in the variable *EU*.
In order to capture the fact that the market may be characterized by additional market entry barriers other than the one considered as explanatory variable for initial market entry costs, f_s, we control for *capital intensity* defined as tangible assets per employee and for *R&D intensity* defined as expenditures for in-house R&D activities per sales.
Further we control for regional and sectoral differences by including an indicator whether the firm is located in eastern Germany (*east*) and define 11 *industry dummies*. For the definition of the industry dummies see Table 3 in the Appendix.

5 Empirical results

To test the influence of the protective effect as well as the impact of the disclosure requirement on the patenting decision we estimate a probit model and calculate marginal effects evaluated at the sample means. The marginal effects of the interaction terms are calculated according to *Cornelißen*, *Sonderhof* (2009). Results are presented in Table 2.
According to our first Hypothesis 1, a decrease of market entry costs should result in a higher probability to patent, i.e. if a high threat of entry is perceived, the propensity to patent should increase. Recall that the interaction term of market entry costs with the easiness of substitutability, $MEC * RE$ reflects the market entry costs of competitors if the innovator patented and thus accounts for the impact of the disclosure requirement. To capture the entire effect of market entry costs – with and without patenting – we evaluate the sole effect and the effect combined with the easiness of substitutability. We find a negative marginal effect concerning the sole effect of market entry costs and a positive effect of the interaction term. As the latter effect is significantly higher than the sole effect, the overall effect of market entry costs is positive and is thus in line with Hypothesis 1.

Table 2: Results of the Patenting Decision Estimation with Horizontally Differentiated Products

	Marginal Effect	**Standard Error**
reverse engineering	0.002	0.044
market entry costs	-0.142**	0.062
large number of firms	-0.056	0.058
*MEC * rev. eng.*	0.305***	0.106
*firms * rev. eng.*	-0.329**	0.143
log(employees)	0.112***	0.017
human capital	0.246**	0.109
R&D intensity	1.405***	0.303
capital intensity	-0.185	0.147
EU	0.070	0.049
non_EU	0.082*	0.048
customer power	-0.059	0.044
cooperation	0.234***	0.044
east	-0.105**	0.043
industry dummies	*included*	
Log likelihood	-372.83	
McFadden's adjusted R^2	0.346	
$\chi^2(all)$	395.00***	
$\chi^2(ind)$	62.59***	
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 those of the interaction terms are 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. For a definition of the industry dummies refer to Table 3.

Hypothesis 2 derived from the theoretical model states that whenever the disclosure requirement has *no* impact, the propensity to patent rises with the number of firms operating in the market. As we find a non-significant effect of the number of firms, we are not able to confirm the hypothesis. Obviously, in the absence of easy substitutability an increase of the number of firms, i.e. a decrease of the critical threshold of patent intensity, has no impact on the patenting decision. This can be due to the fact that the lack of substitutability serves as a natural entry barrier perceived as sufficiently high protection thus making patenting obsolete. Hypothesis 3 regards the case in which the disclosure requirement *has* an impact which following our empirical implementation translates into the fact that substitutability is easy ($RE = 1$). According to the theoretical model, the disclosure effect affects the propensity to patent in two interdependent ways: *(i)* by affecting market entry costs and *(ii)* by thereby affecting the number of entering firms. At the same time the sole effect of disclosure has no impact on the patenting behavior *(iii)*. We test this hypothesis looking at these three effects: *(i)* the interaction of easy substitutability with market entry costs to document the impact of the disclosure requirement on market entry costs, *(ii)* the interaction of easy substitutability with the number of firms in a market which reflects the effect of the disclosure requirement on the number of entering firms and finally *(iii)* the single effect of the disclosure requirement.[5] As conjectured we find a positive effect of the interaction term *MEC * rev. eng.* showing that in the case of easy substitutability decreasing market entry costs increase the probability of patenting. The second interaction term *firms * rev. eng.* revealing the effect of the number of entering firms in the presence of easy substitutability turns out to be negative, which is in line with the proposed effect. Further, as we proposed, the sole effect of easy substitutability is insignificant.

We find significant effects for *firm size*, *R&D intensity*, geographical markets *EU* and *non-EU* and *east*. Additionally, we confirm a significant positive impact of *human capital*, i.e. a higher share of highly qualified employees increases firms probability to apply for patents.

6 Conclusion

From our theoretical analysis of the propensity to patent in a market with horizontally differentiated products we deduced three hypothesis. The first,

[5] Note that the single effect of easy substitutability has to be interpreted as the disclosure effect when neither the dummy variable *MEC* nor the dummy variable *large number of firms* takes unit value.

Hypothesis 1, concerns a basic mechanism of the circular city model: if market entry costs decrease, more firms enter the market. To mitigate this effect, the innovator can patent as this forms an alternative barrier to entry. Thus the hypothesis states that the propensity to patent increases when market entry costs decrease. However, patenting has the drawback of mandatory disclosure which could in turn outweigh the positive protective effect. Our empirical estimation looks at the interdependency of both aspects as we consider the sole effect of market entry costs as well as the interaction of the impact of the disclosure requirement with market entry costs. We find an overall positive effect and can thus confirm the Hypothesis.
The following hypotheses distinguish the case that the disclosure requirement *has* an impact, i.e. more firms are able to enter due to a patent, and the case that the disclosure requirement has *no* impact, i.e. patenting does not change the number of entering firms. If it has *no* impact, Hypothesis 2 suggests that the propensity to patent decreases with the number of firms operating in the market. This finding cannot be confirmed: possibly the lack of substitutability forms a barrier to entry sufficiently high to make patenting obsolete. If the disclosure requirement *has* an impact, Hypothesis 3 proposes that the probability to patent decreases with the strength of the disclosure effect. From the theoretical model we know that this effect is twofold as the disclosure effect influences market entry costs and thereby also affects the number of entering firms. The empirical estimation finds both effects significantly influencing the propensity to patent in the proposed manner: the interaction term of market entry costs and reverse engineering has a positive effect while the interaction term of the number of firms and reverse engineering has a negative effect.
Overall, concerning the propensity to patent in markets with horizontally differentiated products, we find that patents can serve the innovator as an additional barrier to entry when the initial fixed costs of market entry decrease. Furthermore the empirical findings propose that the strength of the disclosure effect is in fact decisive for the innovator's patenting decision.

Appendix

Table 3: Definition of Industry Dummies

ind_	**NACE code**	**description**
1	1, 15, 17, 18, 19	agriculture, food, textile, leather
2	10, 14, 23, 40, 41	mining, coke, fuel, electricity
3	20, 21, 36, 37, 90	wood, paper, publishing, printing, furniture, recycling, sewage
4	24, 25, 26	chemicals and pharmaceuticals, plastics, non-metallic mineral products, glass
5	27, 28	metals
6	29, 34, 350, 351, 352, 354, 355	machinery, motor vehicles without aerospace
7	30, 31, 32	office machinery, electrical machinery, radio television communication
8	33, 353	medical, precision and optical instruments, aerospace
9	64, 72	telecommunication, post and communication, computer services
10	73	research & development
11	74	business activities

Industry category 11 is the reference category and is not included in regressions.

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