

Henrik Sattler

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Prof. Dr. Henrik Sattler

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* Institute of Marketing, Retailing & Management Science, University of Hamburg,
Von-Melle-Park 5, D-20146 Hamburg, Germany
Email: uni-hamburg@henriksattler.de

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Appropriability of Product Innovations: An Empirical Analysis for Germany

Abstract: This paper analyzes the effectiveness of patents and other means of appropriation for protecting the competitive advantages of new products. Data were obtained from the ‘Mannheim Innovation Panel’, which includes more than 1800 German-based firms with at least some new product development activities. In line with past research in the US and several European countries we found for Germany that on *average* patents are a rather ineffective means of appropriation. However, we identified one cluster of firms accounting for about 20% of all firms, where the most effective mechanism of appropriation is patents. We further analyzed by means of logistic regression how this cluster can be characterized and by what factors the perceived effectiveness of patents as a method of appropriation are moderated.

Keywords: Appropriability of Innovations, Innovation Management, New Product Development, Patents, Competitive Advantages

Biographical notes: Since 2000 Prof. Henrik Sattler has been director of the Institute of Marketing, Retailing & Management Science at the University of Hamburg. He received his Ph.D. as well as his Habilitation from the University of Kiel, Germany. From 1995 to 1999 he was Unilever-Chair-Professor of Marketing and Management Science at the University of Jena, Germany. As a visiting fellow he spent a year at Cornell-University, New York in 1992 and several months at the Massachusetts Institute of Technology (MIT) in 1993. He spent two sabbaticals as a visiting faculty at the Australian Graduate School of Management, Sydney in 1999 and 2002. The main focus of Henrik Sattler’s research is on branding, preference measurement, innovation management and retailing. He has published more than 60 articles in these fields in scientific and management-oriented journals (e.g., *Journal of Retailing*, *Zeitschrift für Betriebswirtschaft*, *Zeitschrift für betriebswirtschaftliche Forschung*).

1 Introduction

New product development is a key value driver for firms [e.g. 4,18]. Especially products with a high degree of innovativeness have the potential for sustainable growth of a firm's profit. Schumpeter [16] even points out that the essence of the activity of a firm is innovation.

To have the incentive to undertake new product development, a firm must be able to sufficiently appropriate returns from the product innovation to make the investment worthwhile. If competing firms can imitate an innovation at a cost that is substantially below the cost to the innovator of developing the innovation, there may be little or no incentive for the innovator to carry out the innovation [1,14].

Among the methods of appropriating returns from innovations patents have gained the most interest. In theory, a patent confers perfect appropriability for a limited time (monopoly of the innovation). However, previous research has shown that appropriability is far from perfect [11]. Many patents can be circumvented; others provide little protection because of stringent legal requirements for proof of being valid or in the case of a claimed infringement; a patent also discloses detailed information about the innovation. Schewe [15] for instance found in the German mechanical and electrical engineering industry that for 57.5 % of the innovation projects investigated a patent could not prevent imitations.

Mansfield/Schwartz/Wagner [14] found for a sample of 48 new products in the US that 60% of the patented innovations were imitated within 4 years of their introduction; the average time required for imitation was 70% of the time necessary to innovate and the imitation cost was 65% of the innovation cost. Therefore, it does not come as a surprise that a substantial amount of innovations are not patented [3].

A number of studies has shown that other methods of appropriation are more effective than patents, at least for certain types of innovations, firms and industries. Table 1 gives a summary of the most comprehensive studies considering this issue in the US, Switzerland, Germany, Europe and Japan. Because different measures of effectiveness of appropriation were used across studies, we calculated for each study a rank order of appropriability (with higher numbers representing lower effectiveness). With the exception of the study by Wyatt et al. [19] (who investigated just a small number of firms) patents appear to be on average one of the least effective mechanisms or even the least effective one of protecting the competitive advantages of new products. Instead, means like superior sales or service efforts, lead time and learning curve effects appear to be more effective. Harabi [8] as well as Levin et al. [11] found that the ability of competitors to 'invent around' patented innovations and the perception that patent documents require 'disclosure of too much information' are considered the most important constraints on the effectiveness of patents.

However, there seems to be a substantial amount of variation with respect to the effectiveness of patents as a method of appropriation across firms. E.g., Harabi [8] found that expert judgments of the effectiveness of patents to prevent duplication on a scale ranging from 1 (not at all effective) to 7 (very effective) vary between 2.0 (first quartile) and 5.0 (third quartile). Similar results are found by Levin et al. [11]. A part of this variation was explained

by differences between industries. In the chemical industry, for instance, the mean rating was 4.0, compared to 3.4 for all other industries.

Table 1 Relative Effectiveness[#] of Mechanisms of Protecting the Competitive Advantages of New Products found in Four Studies

		Wyatt et al. [19]	Levin et al. [11]	Harabi [8]	König/Licht [10]	Arundel [2]
		USA/Europe/ Japan n=80 firms	USA n=130 lines of business	Switzerland n=127 lines of business	Germany n=2900 firms	Europe n=2849 firms
Protection rights	Patents	2	3/4	3/4	5	4
	Patents to prevent duplication	3/4	4	6	3/4	3/4
	Patents to secure royalties	3/4	5	5	3/4	3/4
	Registered design		3/4	3/4	6	5
Secrecy	Secrecy in general	4	6	4	4	2
	Complexity of design	3/4	3/4	3/4	3	3
	Long-term employment relationships	3/4	3/4	3/4	1	3/4
Competitive instruments	Lead time	3/4	2	2	2	1
	Learning curve effects/ economies of scale	5	3	3	3/4	3/4
	Costs of imitation for competitors	6	3/4	3/4	3/4	3/4
	Know-how advantages	1	3/4	3/4	3/4	3/4
	Superior sales or service efforts	3/4	1	1	3/4	3/4
	Brand name recognition	3	3/4	3/4	3/4	3/4

Numbers show a rank order where higher numbers represent lower effectiveness

While there have been attempts to explain the variations in the effectiveness of patents in the studies of Harabi for Switzerland [8], Levin et al. for the US [11] and Arundel for Europe [2], there has been very little of such an analysis for Germany. The data reported in Table 1 for Germany are based on the first wave of the ‘Mannheim Innovation Panel’, a survey of approximately 2900 German-based firms. While these data are of potentially high interest, there has been almost no analysis done to date in explaining the variations in the effectiveness of patents as a means of appropriation. König/Licht [10] as well as others used the data on the effectiveness of mechanisms of appropriation mainly as an exogenous variable in models to explain for instance the propensity to patent [10] or the R&D intensity [9].

This paper uses the data of the first wave of the ‘Mannheim Innovation Panel’ to explain in detail the effectiveness of patents and other means of protecting the competitive advantages of new products in Germany. Particularly in Germany there is little evidence on the nature and strength of conditions for appropriability and of how the patent system works.¹ As Levin et al. [11] point out, because imperfect appropriability may lead to underinvestment in new technology, and because technological progress is a primary source of economic growth, it is useful to have a more comprehensive empirical understanding of appropriability, in particular, to identify those industries and conditions in which patents are effective in preventing competitive imitation of a new product.

2 Data source and research approach

The data for our empirical work were taken from the first wave of the ‘Mannheim Innovation Panel’². The Panel is a multi-year innovation survey conducted by the ‘Zentrum für Europäische Wirtschaftsforschung’ (ZEW). The sampling frame stems from the records of Germany’s largest credit rating company (CREDITREFORM). The sample was stratified by industries and firm size classes as well as West- and East-Germany. Besides the topic of appropriability of product innovations the questionnaire covers a broad range of topics related to the innovation process such as patent application or innovation strategy.

Approximately 2900 firms participated in the survey and completed the questionnaire. The response rate was about 24%. The survey covers innovative (65%) as well as non-innovative firms (35%). Based on the data of an additional telephone survey, weighting factors correcting for possible non-response biases from non-innovative companies were applied. We restrict our analysis to innovative firms, i.e., firms which introduced at least one new or improved product in 1990-1992 or intended to do so in 1993-1995. Furthermore, we delete all service-sector firms since their questionnaire contains no information on patents. We also focus our research on product innovations (rather than on process innovations). Finally, we included just those firms with complete or almost complete answers with respect to the variables of interest. Overall, data of 1844 firms are included in this study.³

In order to analyze the relative effectiveness of patents and other means of protecting the competitive advantages of new products we undertook a four-step research approach. First, we did some descriptive analysis on ratings of the relative effectiveness of six mechanisms of protecting the competitive advantages of new products. Second, we tested correlations between the ratings on the effectiveness of the six means of appropriation. When finding strong correlations we conducted a factor analysis with respect to the six mechanisms. Third, based on the factor analysis, we performed a cluster analysis in order to identify homogeneous segments of firms with respect to the effectiveness of alternative means of appropriation. As a result we identified a cluster of firms with very high effectiveness of patents. Fourth, we

¹ Some information for Germany can be found in [10,17]. Arundel [2] in his European study used data from German firms as well, but didn’t analyse Germany separately.

² For a detailed description see [12].

³ The largest enterprises in the sample were split into lines of businesses. We refer to these entities as firms too.

conducted several logistic regression analyses where the dependent variable is membership to this cluster (coded 1 if firms belong to this cluster and 0 otherwise). As predictors we used – based on a literature review – several factors of possible influence on the relative effectiveness of patents as a means of appropriation. In order to get further confidence in our results we estimated, in addition to the logistic regression, several OLS regressions using the ratings of patents as a means of appropriability as dependent variable and as predictors the same variables as for the logistic regression.

3 Results

3.1 Descriptive analysis

Similar to past approaches [e.g. 2,8,11] the effectiveness of mechanisms of protecting the competitive advantages of new products was measured directly on a five-point rating scale ranging from 1 (not at all effective) to 5 (very effective).⁴ The results with respect to six methods of appropriation are indicated in Table 2.

The main findings are in line with past research (see Table 1).⁵ On average patents and registered designs are the least effective means of appropriability. Long-term employment relationships, lead time, complexity of design and secrecy are substantially more effective.

Table 2 Effectiveness of Mechanisms of Protecting the Competitive Advantages of New Products (1 = not at all effective; 5 = very effective)

Method of appropriation	Mean (Stand. Deviation)	First quartile (25%) – Third quartile (75%)
Patents	2.82 (1.51)	1.0 – 4.0
Registered designs	2.51 (1.31)	1.0 – 4.0
Secrecy in general	3.29 (1.37)	2.0 – 4.0
Complexity of design	3.39 (1.28)	3.0 – 4.0
Long-term employment relationships	4.23 (0.96)	4.0 – 5.0
Lead time	4.14 (1.16)	4.0 – 5.0

However, Table 2 also reveals that there is a large variance in the data, particularly for the effectiveness of patents. The middle 50% of all the answers for this variable lie between 1.0 and 4.0, i.e., some companies rate the effectiveness of patents rather high, whereas other

⁴ A discussion of methodological problems of this approach can be found in [11].

⁵ Note that König/Licht [10] and this research used both the first wave of the ‘Mannheim Innovation Panel’. However, a different set of firms was selected in the two analyses resulting in (slightly) different results.

companies rate it low. Similar results were found by past research in the US and Switzerland [8,11].

The large variance documented in Table 2 suggests that it might be fruitful to segment companies into clusters distinguishable by a primary means of appropriability. Segments can be identified by means of cluster analysis.

3.2 Segmentation analysis

Before conducting the segmentation analysis we first tested correlations between the ratings on the effectiveness of alternative means of appropriation. We found strong correlations between patents and registered designs on the one hand and between secrecy, complexity of design, long-term employment relationships and lead time on the other hand. Using standard factor analysis (principal component analysis with varimax rotation) we found in accordance with these results two factors (see Table 3). Applying a variety of factor-analytic techniques did little to alter the picture presented in Table 3. Similar results were obtained by König/Licht [10] and Levin et al. [11]. The latter extracted two factors grouped under the headings patent and non-patent mechanisms for the protection against imitation. Our analysis as well as those by König/Licht [10] show that the results of the Levin et al. [11] study in the US, which used a sample of about 500 firms, can be reproduced for Germany with a large data set including also a large variety of firm sizes and industries.

Table 3 Principal Components Analysis of Mechanisms of Protecting the Competitive Advantages of New Products (Factor loadings, varimax rotation)

Method of appropriation	Factor 1	Factor 2
Patents	0.070	0.870
Registered designs	0.096	0.855
Secrecy in general	0.557	0.398
Complexity of design	0.746	0.007
Long-term employment relationships	0.696	0.042
Lead time	0.687	0.329

60% variance explained; KMO = 0.709; Bartlett's Test of Sphericity: $p < 0.001$
Cronbach's α : 0.66 for factor 1 and 0.75 for factor 2

Based on the factor analysis we next performed a cluster analysis in order to identify homogeneous segments of firms with respect to the effectiveness of alternative means of appropriation. As cluster variables we used the summed scores of the two factors identified. The use of the summed scores rather than the original ratings on the six methods of appropriation as cluster variables avoids several methodological problems [7]. The cluster

analysis was done by means of a Ward algorithm. Before applying this algorithm we first used a single-linkage procedure in order to identify outliers. Based on an inspection of the corresponding dendrogram we reduced the data set by 88 firms (i.e., 4.8% of the total sample), resulting in a sample of 1756 firms. The Ward algorithm leads to a three-cluster solution using the Kaiser-criterion. Attempts to improve this solution further by K-Means and other procedures were not successful.⁶

The results of the cluster analysis in Table 4 show three distinct segments of firms. For cluster 1 with 19.5% of all firms patents are the most effective way of protecting the competitive advantages of new products, even (slightly) more effective than lead time and long-term employment relationships. Also registered designs are far more important compared to the corresponding value for the total sample (see Table 2). Firms assigned to cluster 3 (22,6% of the sample) have relatively low scores for all mechanisms of appropriation investigated. Possibly these firms use methods of appropriation not investigated in this study (see Table 1 for alternative methods). In addition, we found a significantly ($p < 0.001$) lower R&D-intensity for cluster 3 (2.0%) than for both cluster 1 (2.85%) and cluster 2 (2.95%). As Arundel [2] points out, R&D-intensity can be positively related to the value of patents by increasing the proportion of inventions that are patentable. Firms in cluster 2, the largest segment with 58.0% of the total sample, have ratings that are similar to the total sample (see Table 2), with somewhat lower values for patents, registered designs and secrecy, and higher values for complexity of design, long-term employment relationships and lead time.

Table 4 Cluster Analysis of Mechanisms of Protecting the Competitive Advantages of New Products (Mean: 1 = not at all effective; 5 = very effective)

Method of appropriation	Cluster		
	1 (342 firms)	2 (1018 firms)	3 (396 firms)
Patents	4.5	2.5	2.1
Registered designs	4.0	2.3	1.8
Secrecy in general	3.6	3.6	2.3
Complexity of design	2.9	4.0	2.3
Long-term employment relationships	4.0	4.6	3.7
Lead time	4.4	4.5	3.2

Summarizing the results of the cluster analysis, the most interesting finding is that there is a certain segment with about 20% of all firms, where the most effective mechanisms of

⁶ For the several clustering procedures applied see e.g. [7].

appropriation are patents. Thus, findings of previous research pointing out that patents are an ineffective mechanism of appropriation compared to other means (see chapter 1) do not hold – at least in Germany – for all firms.

3.3 *Regressions analysis*

The question arises how the identified segment of firms with very high effectiveness of patents (cluster 1) can be characterized, i.e. how it differs from the other clusters with very low effectiveness of patents as a mechanism of appropriation. In order to answer this question we conducted several logistic regression analyses where the dependent variable is membership to cluster 1 (coded 1 if firms belong to cluster 1 and 0 otherwise). As independent variables we used several factors of possible influence on the relative effectiveness of patents as a means of appropriation. These factors were identified by a literature review on studies dealing with the effectiveness of methods of protecting the competitive advantages of new products. The following predictors were used:

- External factors: type of industry [2,8,11,13,19) and country [19],
- Firm-related factors: firm size [2],
- Product-related factors: degree of innovativeness of the new product [15], perceived risk of imitation of the new product [15], perceived risk associated with the success of the new product [13], length of product life cycle [4], and
- Strategy-related factors: innovation strategy as indicated by R&D intensity [2], patent application [10] and information sources used for product development (e.g. cooperative R&D arrangements with external firms versus internal R&D [2]).

With respect to the four variables degree of innovativeness (measured as percentage of revenues with really new products), length of product life cycle (in years), R&D intensity (ratio of the R&D spending with revenues) and information sources used for product development (measured in a yes or no format whether a firm had any cooperative R&D arrangements with external firms) we observed missing-data problems as well as some multicollinearity effects with the other independent variables. Therefore, we decided not to include these variables simultaneously with the other independent variables in the logistic regression. Instead we undertook univariate analyses for these four variables.

In order to get further confidence in our results we estimated, in addition to the logistic regression, an OLS regression using the ratings of patents as a means of appropriability (ranging from 1 = not at all effective to 5 = very effective) as dependent variable. As predictors the same variables as for the logistic regression were applied.

The results of the univariate analyses are shown in Table 5. It can be seen that all four variables explain very little variance. Furthermore, only the variables cooperative R&D arrangements and, to some extent, R&D intensity have significant effects. The exp (regression coefficient) in Table 5 (as well as in Table 6, see below) can be interpreted as the extent to which the odds of belonging to cluster 1 will change if the independent variable changes by one unity. E.g. a firm that undertakes cooperative R&D has a 1.31% higher probability of belonging to cluster 1 compared to a firm without R&D arrangements. The OLS-regression

coefficients in Table 5 (as well as in Table 6, see below) show the change in the effectiveness of patents if the independent variable changes by one unit. E.g., if a firm increases R&D intensity by for instance 0.1 the rating of the effectiveness of patents is predicted to increase by 0.535 units on the five- point rating scale. The signs of all at least partly significant variables in Table 5 are as expected. R&D intensity can be seen as an important characteristic of a firm’s innovation strategy [2]. As Arundel [2] points out, R&D intensity should be positively related to the value of patents by increasing the proportion of inventions that are patentable, or by increasing the value competing on the basis of innovation relative to price. It can also be expected that firms that extensively use external sources for the development of new products that require the sharing of valuable information – such as cooperative R&D arrangements – could find patents of great value, because patents could play an important role in clarifying ownership [2]. This expectation can be supported by our data as well as by those of Arundel for Europe [2] and Brouwer/Kleinknecht for the Netherlands [5]. However, one has to keep in mind that only little variance can be explained.

Table 5 Moderating Variables on the Effectiveness of Patents for Protecting the Competitive Advantages of New Products (Univariate Analyses)

Independent Variables	Logistic Regression Dependent Variable: Membership to cluster 1 (high effectiveness of patents):		OLS-Regression Dependent Variable: Effectiveness of patents (1= not at all effective; 5 very effective):	
	Exp (Regression coefficient); constant in parentheses	Nagelkerkes R ²	Regression coefficient; constant in parentheses	R ²
Degree of innovativeness	0.00 (-1.42***)	0.000	0.00 (2.88***)	0.001
Length of product life cycle	0.01 (-1.33***)	0.000	0.01** (2.87***)	0.005
R&D intensity	0.98 (-1.46***)	0.000	5.35*** (2.64***)	0.021
Cooperative R&D arrangements	1.31** (-0.22***)	0.004	0.54*** (2.58***)	0.032

* p<0.10; ** p<0.05; *** p<0,01

The non-significant effects in Table 5 are also interesting. They mean that the perceived effectiveness of patents for protecting new products (respectively the probability of belonging to the cluster of firms where the most effective mechanisms of appropriation are patents) is independent from the degree of innovativeness of a new product and the length of the product life cycle. Thus, for highly innovative products the perceived effectiveness of patents is the same as for products with a low degree of innovativeness.

Next, the other predictor variables described above were entered simultaneously to the logistic and OLS-Regression analyses. For each type of regression analysis two different models were estimated, one (LG 1 and OLS 1) not including, and the other one (LG 2 and OLS 2) including the variable patent application (see Table 6). This procedure seemed to be appropriate because of some multicollinearity problems between the patent application and the other variables. The coefficients in Table 6 can be interpreted in the same way as those in Table 5 (see above).

First, Table 6 shows some significant industry effects (measured by dummy variables, where an industry with a very low rating on the effectiveness of patents, i.e., construction, was taken as the reference category). In line with previous research [e.g. 8,11] we find significant positive coefficients for certain industries such as chemicals, mechanical engineering and steel/basic metals meaning that in those industries patents are perceived as more effective. It also means that in cluster 1 these industries are overrepresented.

The second variable in Table 6 shows a country effect for East Germany, i.e., patents are perceived as less effective in East Germany compared to West Germany, and firms from East Germany are underrepresented in cluster 1. These effects could be due to the unique economic situation in East Germany shortly after the reunification of Germany. One reason could be that new product developments of firms from East Germany at that time were still mainly aimed at countries in Eastern Europe, which had been by far the most important market before 1990. These products faced new competitors from western countries with substantial competitive advantages. In such a situation patents seem to be a non-effective method of appropriation.

Firm-size effects – at least for large companies – turned out to be mostly significant with large firms being overrepresented in cluster 1 and perceiving patents as a more effective means of appropriation (see Table 6). This finding is in line with several other studies [e.g. 2]. The fact that small firms value patents less highly than large firms is of concern to German (and European) policy that fosters small (high-technology) start-up firms. This difference is unlikely to be due to smaller firms having only few patentable innovations, because the analyses have intentionally excluded firms that do not develop new products and are, therefore, less likely to come up with patentable inventions. One explanation for the difference is that small firms lack the financial resources to protect their patents from infringement [2].

Finally (see Table 6), we investigated perceived imitation risk as well as perceived innovation risk, both measured on a five-point rating scale ranging from 1 (very low) to 5 (very high). Imitation risk turned out to be non-significant for all types of analyses, meaning that effectiveness of patents as well as membership for cluster 1 is independent from the perceived level of imitation risk associated with the new product. This result is a strong hint that patents are an imperfect instrument for protecting product innovations against imitation. Results in Table 6 also reveal that members of cluster 1 can not be distinguished by the innovation risk in general. However, this variable turns out to be significant in the OLS-Regression. As expected, the effectiveness of patents increases with increasing perceived innovation risk.

Table 6 Moderating Variables on the Effectiveness of Patents for Protecting the Competitive Advantages of New Products (Multivariate Analyses)

Independent Variables	Logistic Regression (LR) Dependent Variable: Membership to cluster 1 (high effectiveness of patents): Exp (Regression coefficient)		OLS-Regression (OLS) Dependent Variable: Effectiveness of patents (1= not at all effective; 5 very effective): Regression coefficient	
	LR (1)	LR (2)	OLS (1)	OLS (2)
Industry dummies #				
Chemicals	2,12***	1,80**	0,78***	0,57***
Mechanical engineering	1,97***	1,65*	0,78***	0,49***
Electrical engineering	1,70*	1,50	0,44***	0,24*
Steel, basic metals	2,36***	2,30***	0,38**	0,34**
Medicine equipment, optics	1,76*	1,48	0,35**	0,13
Metal working	0,96	0,94	0,23	0,23
Plastics, rubber	1,63	1,64	0,29	0,24
Paper, wood processing	1,01	0,94	-0,14	-0,23
Transport equipment	1,57	1,24	0,37**	0,15
Mining, energy	0,89	0,86	-0,53*	-0,57**
Food	1,03	1,11	-0,36*	-0,24
Former East Germany	-0,66***	-0,78*	-0,34***	-0,14**
Firm size dummies ##				
50 – 249 employees	1,18	1,05	0,24***	0,11
more than 249 employees	1,36**	0,91	0,71***	0,24***
Perceived imitation risk (1=very low; 5 very high)	1,02	1,03	0,03	0,03
Perceived innovation risk (1=very low; 5 very high)	1,04	1,00	0,14***	0,10***
Patent application	—	2,42***	—	1,20***
Constant	0,12***	0,12***	1,70***	1,71***
Nagelkerkes R ² / R ²	0,040	0,073	0,174	0,282

Reference category: Construction industry; ## Reference category: firms with less than 50 employees

Overall explained variance in the models LG (1) and OLS (1) is low, especially for LG (1). I.e., the perceived effectiveness of patents as a means of appropriation as well as membership to cluster 1 are determined to only a small degree by the type of industry, firm size, country, perceived imitation risk and perceived innovation risk. Degree of innovativeness, length of

product life cycle, R&D intensity and cooperative R&D arrangements also explain very little variance.

However, including patent application in the models (see LG 2 and OLS 2 in Table 6) has a substantial effect. It can be seen that patent application is by far the most important variable. As expected [10], patenting firms rate patents as more effective than non-patenting firms. Thus, patenting firms believe much more than non-patenting firms that patents work as an instrument for protecting the competitive advantages of new products. However, it is questionable whether patents really work, given the little or even insignificant effects of the other variables investigated, e.g. those of perceived imitation risk and innovation risk.

One possible explanation for our results might be drawn from dissonance theory [6]. Patenting firms put a lot of time and money in the patent application process and also disclose valuable information about their new products to competitors. A firm should do this only if patents are an effective means of appropriation. If a firm, after patent application, experiences some doubt about the effectiveness of the patent, a dissonant cognition might result. The cognition “I put a lot of money and time into patents and run the risk of giving valuable information to my competitors” and the cognition “patents don’t work effectively” behave in a dissonant manner. Dissonance theory postulates that people, including managers, have a motivation to reduce dissonances. This motivation increases with the strength of the dissonance, which is assumably very strong in the patent case. A common way to reduce dissonances is to question the cognition which causes the dissonances, i.e., in our case to question doubts about the effectiveness of patents. Thus, one possible reason that patenting firms perceive patents as very effective is their motivation for dissonance reduction. If this is true there is a psychological bias on the ratings concerning the patent effectiveness for patenting firms.

4 Summary and Conclusions

This paper uses the data of the first wave of the ‘Mannheim Innovation Panel’ to explain the effectiveness of patents and other means of protecting the competitive advantages of new products in Germany. Answers from 1844 firms are included in this study. In line with past research in the US and several European countries, we find for Germany that on *average* patents as well as registered designs are the least effective means of appropriability. Instead, long-term employment relationships, lead time, complexity of design and secrecy are substantially more effective. Nevertheless, we find substantial variance in the ratings of patents as a means of appropriation. By analyzing this variance we identify a cluster of firms accounting for about 20% of all firms, where the most effective mechanisms of appropriation are patents. Thus, findings of previous research pointing out that patents are an ineffective mechanism of appropriation compared to other means do not hold (at least in Germany) for all firms.

We further analyze by means of logistic regression how the cluster of firms with very high effectiveness of patents can be characterized and how it differs from the other firms with very low effectiveness. We found that the type of industry, country (East versus West Germany), firm size, several product-related factors such as degree of innovativeness, perceived risk of

imitation, perceived innovation risk as well as strategy-related factors like R&D intensity and cooperative R&D arrangements explain partly some, but overall very little of the variance concerning cluster membership. This is also true for an analysis of the impact of these variables directly on the ratings of effectiveness of patents as a means of appropriation. As in previous studies for the US and Europe, only industry, firm size and country have some moderating effects. The only variable with very strong exploratory power is patent application. Patenting firms rate patents as more effective than non-patenting firms. Thus, patenting firms believe much more than non-patenting firms that patents work as an instrument for protecting the competitive advantages of new products.

Given that variables such as perceived imitation risk and innovation risk have almost no influence on the effectiveness of patents as instrument of appropriation, we argue that our result concerning the patent application could be due to a psychological bias on the ratings of patent effectiveness. Using the theory of cognitive dissonance it can be speculated that cognitions of patenting firms like “I put a lot of money and time into patents and risk to give valuable information to my competitors” and “patents don’t work effectively” cause cognitive dissonance, which make patenting firms – by avoiding such a dissonance – believe that patents must be an effective means of appropriation (although in reality they are not).

Overall, we add evidence for Germany to the findings of previous studies in other countries that patents are a rather ineffective way of protecting the competitive advantages of new products. This holds even for new products with a high degree of innovativeness, a high risk of imitation and a high general risk of success.

Further research is needed to characterize the identified segment of firms (which we believe does not exist just in Germany), that perceives patents as a very effective way of appropriation. In particular, it would be of high interest whether the psychological bias related to the theory of cognitive dissonance as proposed in this study can be proved by future research.

One has to keep in mind that this research has at least two limitations. First, the use of one-dimensional semantic scales to assess the effectiveness of alternative means of appropriation may bear some measurement error [11]. Future research should try to develop more elaborate multi-item measures or measures which are not based on expert judgments. Second, the set of predictor variables used are limited due to the data set.

References

- 1 Arrow, K. (1962) ‘Economic Welfare and the Allocation of Resources for Invention’, in: R.R. Nelson (Ed.): *The Rate and Direction of Inventive Activity*, Princeton: University Press.
- 2 Arundel, A. (2001) ‘The Relative Effectiveness of Patents and Secrecy for Appropriation’, in: *Research Policy*, Vol. 30, pp. 611-624.

- 3 Arundel, A. and I. Kabla (1998) 'What Percentage of Innovations are Patented? Empirical Estimates for European Firms', in: *Research Policy*, Vol. 27, pp. 127-141.
- 4 Brockhoff, K. (1999) *Produktpolitik*, 4. ed., Stuttgart, New York: UTB.
- 5 Brouwer, E. and A. Kleinknecht (1999) 'Innovative Output and a Firms's Propensity to Patent. An Exploration of CIS Micro Data', in: *Research Policy*, Vol. 28, pp. 615-624.
- 6 Frey, D. (1978) 'Die Theorie der kognitiven Dissonanz', in: D. Frey (Ed.): *Kognitive Theorien der Sozialpsychologie*, Bern et al., pp. 243-292.
- 7 Hair, J.F., R.E. Anderson, R.L. Tatham and W.C. Black (1998) *Multivariate Data Analysis*, 5. ed., Upper Saddle River, N.J.: Prentice-Hall.
- 8 Harabi, N. (1995) 'Appropriability of Technical Innovations. An Empirical Analysis', in: *Research Policy*, Vol. 24, pp. 981-992.
- 9 Harhoff, D. (1997) 'Innovationsanreize in einem strukturellen Oligopolmodell', in: *Zeitschrift für Wirtschafts- und Sozialgeschichte*, Vol. 117, pp. 332-364.
- 10 König, H. and G. Licht (1995) 'Patents, R&D and Innovation. Evidence from the Mannheim Innovation Panel', in: *Ifo-Studien*, Vol. 41, pp. 521-545.
- 11 Levin, R.C., A.K. Klevorick, R.R. Nelson and S.G. Winter (1987) 'Appropriating the Returns from Industrial Research and Development', in: *Brookings Papers on Economic Activity*, Vol. 3, pp. 783-820.
- 12 Licht, G. and K. Zoz (1996) 'Patents and R&D. An Econometric Investigation Using Applications for German, European and US Patents by German Companies', in: *ZEW Discussion Paper No. 96-19*.
- 13 Mansfield, E. (1986) 'Patents and Innovations: An Empirical Study', in: *Management Science*, Vol. 32, pp. 173-181.
- 14 Mansfield, E., M. Schwartz and S. Wagner (1981) 'Imitation Costs and Patents: An Empirical Study', in: *The Economic Journal*, Vol. 91, pp. 907-918.
- 15 Schewe, G. (1993) 'Kein Schutz vor Imitation. Eine empirische Untersuchung zum Paradigma des Markteintrittsbarrieren-Konzeptes unter besonderer Beachtung des Patentschutzes', in: *Zeitschrift für betriebswirtschaftliche Forschung*, Vol. 45, pp. 344-360.
- 16 Schumpeter, J.A. (1976) *Capitalism, Socialism and Democracy*, London: George Allen and Unwin.
- 17 Täger, U.C. (1989) 'Entwicklungstendenzen im Patentverhalten deutscher Erfinder und Unternehmen', in: *Ifo-Schnelldienst*, Vol. 42 (23), pp. 14-26.
- 18 Urban, G.L. and J.R. Hauser (1993): *Design and Marketing of New Products*, 2. ed., Englewood Cliffs, N.J.: Prentice-Hall.
- 19 Wyatt, S., G. Bertin and K. Pavitt (1985) 'Patents and Multinational Corporations: Results from Questionnaires', in: *World Patent Information*, Vol. 7 (3), pp. 196-212.

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