

IP Protection Strategies of German Innovators

Knut Blind

(TU Berlin, Fraunhofer ISI);

Bernd Ebersberger,

MCI Management Center Innsbruck

Universitätsstr 15, A-6020 Innsbruck

bernd.ebersberger@mci.edu

Abstract

The paper illustrates the use of intellectual property rights and other protection strategies by German companies differentiated by company size and sector and even by time. Based on a set of hypotheses, various regression analyses are performed to identify factors explaining the use and importance of the various protection instruments. In general, larger companies make a more intensive use of all protection strategies, the same is true for companies of higher innovation intensity. However, depending on the collaboration activities companies are very selective regarding the use of very specific protection means. The paper concludes with some challenges for policy makers.

1 Introduction

The effective protection of intellectual property is an important incentive and therefore also a necessary condition for investment in innovation activities. The increasing significance of technological knowledge for entrepreneurial success is reflected in the doubling of the patent applications by German companies in the 1990s (Blind et al. 2004). In addition, the registration of trademarks for new products - and above all for new services - enjoyed growing popularity, an enthusiasm which was only dampened by the end of the Internet euphoria in 2001 (Schmoch 2003). Generally protection mechanisms can be divided into two groups of measures:

- Formal protection mechanisms are state guaranteed instruments which grant inventors and innovators an exclusive right to utilise exploitation-relevant facts of innovation activities, for a limited time period only. Besides patents and trademarks, utility patents or copyright are among these.
- Strategic protection mechanisms encompass various measures on the part of companies to prevent spill-overs of own innovation efforts and thus to safeguard the appropriation of one's own innovation returns. Typical forms are secrecy, complex design of new products or services which make imitation more difficult, or an extremely rapid implementation of innovation projects and thus a time lead over competitors.

The aim of this contribution is to present the relevance of formal property rights and strategic protection mechanisms for firms' innovation activities. Firstly, the relevance of the protection mechanisms are dealt with by temporal and sectoral comparison, and secondly, determining influential factors besides sector-specific influences for utilising the different instruments.

Regarding the analysis of factors influencing the use of strategies to protect intellectual property, we observe a vast amount of literature focusing on patents in the last twenty years starting with Mansfield (1986), over Levin et al. (1987) and Cohen et al. (2000; 2002) to Peeters and van Pottelsberghe de la Potterie (2006). Blind et al. (2006) analyse even the factors determining various motives to patent. The use of other formal protection rights received less attention. The factors influencing trademarks is firstly analysed by Allegrezza and Guard-Rauchs (1999). Schmoch (2003) investigates the interrelationship between the registration of trademarks and the application of patents. The prosecution of copyright did not attract many researchers, because it is – in general – not registered in databases. Only in the context of the discussion on the patentability of software, Graham and Mowery (2003) focused on the interaction of the use of copyright and patents to protect software.

The use of strategic or informal protection instruments is also mainly analysed in the context of patenting. Especially the interrelationship between patenting and secrecy has been recently in the focus of the research, e.g. by Arundel (2001) or Hussinger (2006). In general, they find

some kind of complementarity. The aim to achieve lead-time advantage in relation to competitors as a protection strategy is discussed in general not in the context of intellectual property rights, but very extensively in relation to competition strategies, especially first-mover advantages and the timing of the market introduction of new products. Besides several theoretical analyses about first- and second-mover advantage (e. g. Hoppe, Lehmann-Grube 2001), the empirical work started with some conceptual approaches by Kerin et al. (1992) and VanderWerf and Mahon (1997) before in the last years various empirical investigations focused on the success of first- or second-mover strategies (Lambert, Slater 1999; Vakratsas et al. 2003) or in general the timing of market introduction (Lilien, Yoon 1990). However, the determinants of selecting a first-mover strategy to achieve lead-time advantage have not been analysed so far. The other remaining protection instruments have gained attraction in the various studies around the discussion on the extension of the patentability to software-based inventions (Blind et al. 2005; Stolpe 2000).

Besides a large amount of literature describing the use of protection mechanisms and analysing the factors no paper gives a comprehensive and comparative overview of the factor influencing the use of the very different types of protection instruments. This paper aims for the first time to analyse in a comparative way the factor explaining the use of formal intellectual property rights and of more informal protection strategies. These results will provide both companies and policy makers with new insights in order to adapt protection strategies or protection policy schemes.

The remainder of the paper is structured as follows. In chapter 2, the data set is briefly described before a descriptive overview is given on the use of protection measures. Based on a set of hypotheses, Chapter 3 focuses on the factors explaining the use of property rights and protection mechanisms. In the final chapter 4 a comparative summary of the results is given and possible policy challenges are addressed.

2 Property Rights and Strategic Protection Mechanisms in Comparison

2.1 Data set

Our analysis bases on the German edition of the fourth Community Innovation Survey (CIS4) covering the years 2002–2004. The CIS, jointly launched by Eurostat and the Innovation and SME Program in 1991, aims at improving the empirical basis of innovation theory and innovation policy on the European level by surveying innovation activities at the enterprise level in the Member States' economies. The CIS surveys collect firm-level data on innovation activities across member states by means of largely harmonized questionnaires. The Community Innovation Survey closely reflects the definitions of the Oslo Manual (OECD 1997) and hence provides a good coverage of the indicators for innovation input, innovation output, innovation strategy and the use and appreciation of IP protection strategies employed by innovating enterprises. For inter-temporal comparison we utilize the German edition of the third Community Innovation Survey (CIS3) covering the years 1998-2000, an analysis of the measures for IP protection of which can be found in Schmoch (2002) and Rammer (2003).

The innovation survey inquires with innovation companies on their usage of a set of measures to protect their IP: patents; utility model, trade marks, copyright, secrecy, complexity of design and lead time advantage. The survey also inquires about the appreciation of the used protection measures on a three level Likert scale (high – medium – low).

2.2 Usage of protection measures – an overview

In order to depict the relative importance of the various forms of protection and strategic protection mechanisms, in Figure 2-1 we present the shares utilised by successfully innovating companies. Figure 2-2 portrays the change of corresponding innovator shares of 2002 – 2004 compared with the period 1998 - 2000.

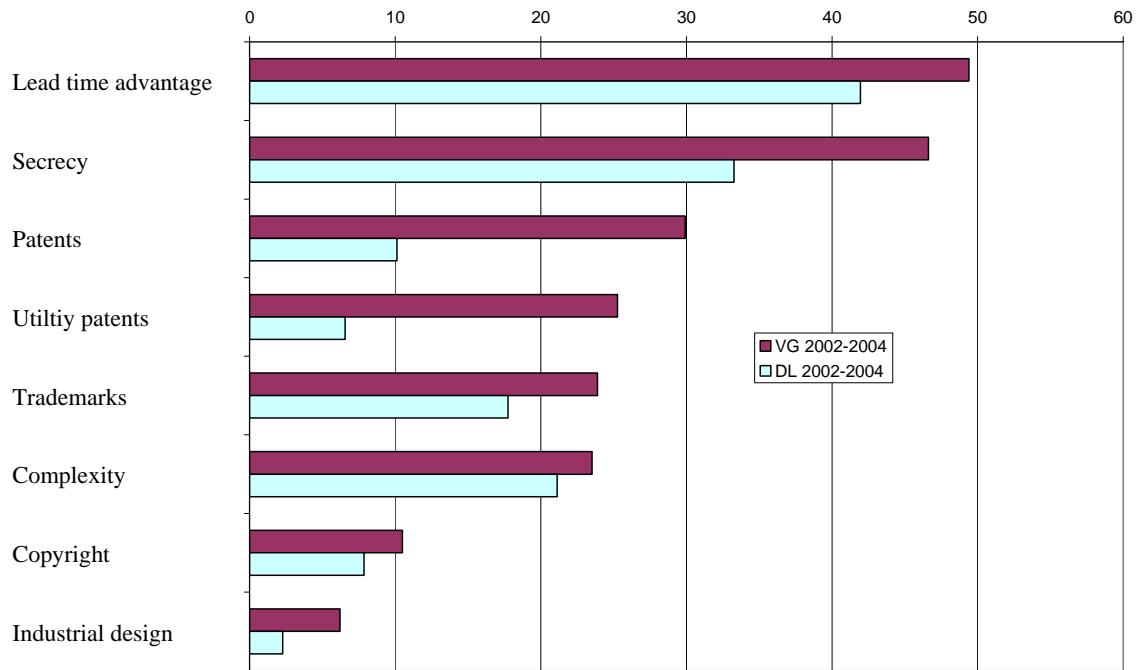
Compared to the different property rights, the strategic protection mechanisms of *first mover advantage* and *secrecy* are both accorded distinctly more importance. Approx. 50 % of all innovators in manufacturing industry and somewhat over 40 % of the service innovators try to appropriate the returns on their innovation output via time leads, i.e. *first mover advantages*. However, the comparison with the period 1998 - 2000 shows that the relative importance of this instrument has stagnated. Obviously, the protection potentials which are derived from lead time advantage are relatively exhausted. If enterprises further attempt to introduce innovations to the market faster than their competitors, then other reasons such as customers' demands / specifications could play a more decisive role.

The second most important instrument is secrecy. Unlike patent protection in which the specifications of new technologies must be disclosed, (successful) secrecy agreements permit excluding third parties from access to innovation-relevant knowledge developed in the company. Nearly half of the innovators in manufacturing industry and somewhat over 30% in the service sector pursue this strategy. It clearly gained in attractiveness, compared with the period 1998 - 2000. Almost 20% more innovators in manufacturing industry and almost 80% more innovators in the service sector attempt to safeguard their innovation returns by means of secrecy agreements.

Ranking third in the importance ranking for protection instruments for manufacturing industry is patent protection, which 30% of the innovators utilize, whereas only 10% do so in the service industry. This however corresponds to an increase of 20%. Obviously the potential of patent applicants among the innovators in manufacturing industry is almost exhausted, while there are even more potential patent applicants among the innovators in the service sector. In this sector the strategic mechanism of complex product design is utilised by over 20% of innovators, which thus takes third place with an increase of over 40%. In manufacturing industry, only a quarter of the companies take advantage of this strategy. The two formal forms of protection registered design and trademark protection are utilised more frequently in this sector. Both property rights are used much more frequently compared with the period from 1998 until 2000. The possibility to file a trademark is taken advantage of in the meantime by almost 20% of the innovators in the service sector, which corresponds to an increase of ca. 50% compared to the period from 1998 to 2000.

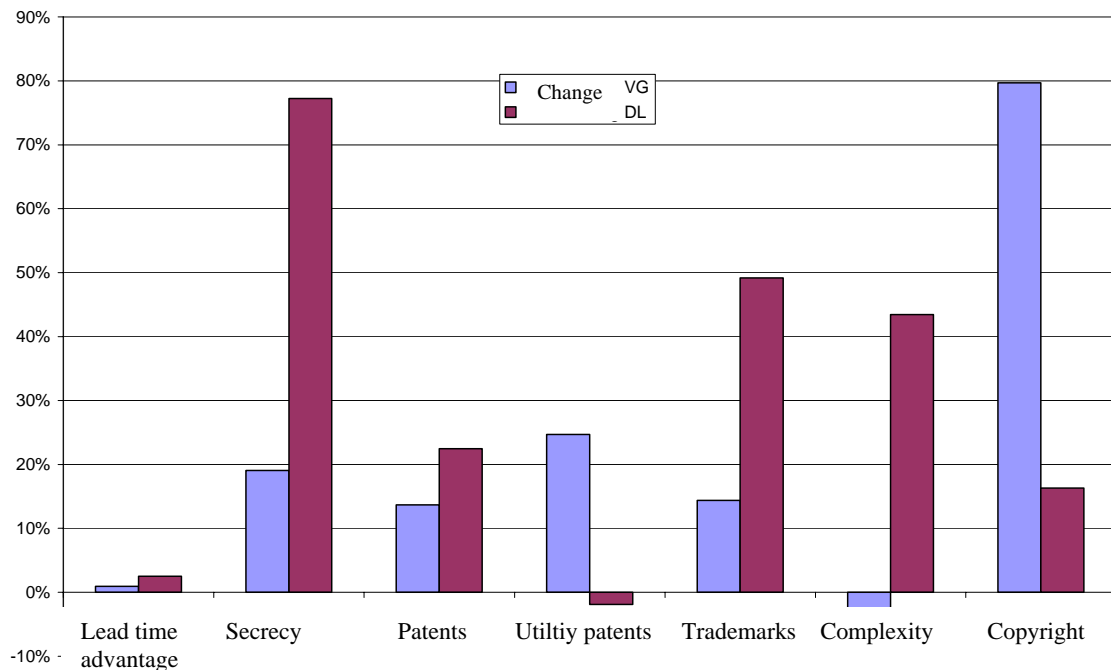
The assertion of copyrights and the entry of industrial designs (design patents) are utilised by 10% of the innovators at most. However, use of copyright protection has grown by 80% in manufacturing industry, in the service sector on the other hand by less than 20%. The background for this considerable increase in manufacturing industry is possibly the increasing production and distribution of accompanying handbooks and materials which are covered by copyrights. Finally, 6% of the companies in manufacturing industry file for protection of industrial designs or design patents. This formal property protection right is practically not used in the service sector.

Figure 2-1:
*Diffusion of Protection Mechanisms for Innovations in Manufacturing Industry (VG) and the
Service Sector (DL) in Germany between 2002-2004*



Source: ZEW/ISI: Mannheimer Innovationspanel 2005.

Figure 2-2
Change in Diffusion of Protection Mechanisms for Innovations in Manufacturing Industry (VG)
and Service Sector (DL) in Germany between 1998-2000 and 2002-2004



Source: ZEW/ISI: Mannheimer Innovationspanel 2005.

Differentiating the utilisation of protection instruments according to enterprise size classes, as depicted in Table 2-1, shows a well known and distinct pattern for manufacturing industry. The share of users increases with growing company size. The difference in the user shares between large enterprises and small enterprises is particularly distinctive with formal property rights, such as e.g. patents - 21% for small enterprises versus 79% for large enterprises. The strategic protection mechanisms like complexity of product design, the difference lies merely between 22% and 34%. This structural difference is caused above all by the fact that the utilisation of formal property rights usually requires a department or person responsible for IPR to be established/ appointed, which cause high fixed costs and are more easily compensated for by large enterprises via corresponding economies of scale. The implementation of strategic protection mechanisms can be decided on a product-to-product basis and as a rule this decision is taken decentralised by the involved engineers and product developers.

In the service sector a different utilisation structure is encountered with regard to enterprise size. By and large, an increase in utilisation cannot be determined in correlation with increasing company size. Compared to the previous survey referring to the period 1998-2000 (Rammer

2003), patents are now used by small and large enterprises in the service sector to the same extent. The large firms hardly stand out from the other service enterprises with a share of 32% in trademark registration. For the strategic protection mechanisms, a U-shaped form can even be distinguished in the user shares. Small and large firms utilise these instruments in particular. This clearly indicates that, on the one hand, small service providers with niche products rely on the first mover advantage ahead of competitors and, on the other hand, large companies want to secure large market shares by speedy market entry and possibly also positive network effects. Secrecy clauses and complex design of innovative services can also rather be realised in small companies, while medium-sized enterprises will find it easier to build structures which lead to an effective implementation of these strategies.

Table 2-1: Utilisation of Protection Instruments for Innovations by Innovators in Manufacturing Industry and Service Sector in Germany between 2002-2004 acc. to Company Size Classes

Manufacturing Industry	Up to 49	50-99	100-499	from 500
Patents	21%	25%	49%	79%
Registered design	18%	21%	42%	58%
Utility model	4%	8%	7%	21%
Trademark	18%	21%	36%	57%
Copyright	9%	6%	16%	26%
Secrecy	37%	52%	61%	81%
Design complexity	22%	24%	25%	34%
Lead time advantage	43%	48%	63%	81%
Service Sector	Up to 49	50-99	100-499	From 500
Patents	10%	9%	9%	11%
Registered design	6%	10%	6%	11%
Industrial design	2%	1%	1%	4%
Trademarks	18%	15%	18%	32%
Copyright	8%	9%	5%	11%
Secrecy	34%	28%	28%	49%
Design complexity	22%	14%	18%	23%
Lead time advantage	43%	37%	31%	50%

Table 2-2: Change of Protection Instrument Use for Innovations by Innovators in Manufacturing Industry and Service Sector in Germany between 2002-2004 compared with 1998-2000 acc. to Company Size Classes

Manufacturing Industry	Up to 49	50-99	100-499	From 500
Patents	16%	-4%	25%	3%
Utility model	50%	-6%	24%	2%
Trademarks	23%	-5%	16%	10%
Copyright	301%	-35%	54%	23%
Secrecy	22%	16%	19%	8%
Design complexity	-1%	9%	-4%	-29%
Lead time advantage	-1%	-3%	8%	2%
Service Sector	Up to 49	50-99	100-499	From 500
Patents	28%	34%	-23%	-51%
Registered design	3%	17%	-48%	-49%
Trademarks	70%	-35%	-19%	2%
Copyright	31%	-26%	-55%	-43%
Secrecy	92%	0%	19%	2%
Design complexity	59%	-37%	-17%	-29%
Lead time advantage	4%	7%	-17%	-9%

If one contemplates Table 2-2, which represents the change in utilisation of protection instruments for innovations by innovators between the periods 1998-2000 and 2002-2004, it is striking that, from a company size of 100 and more employees, with the exception of secrecy, the use of almost all protection measures by innovators in the service sector decreases, whereas manufacturing industry registered a distinct increase in utilisation. We find a decrease in use, even if only a light one, above all with the enterprises employing a work force between 50 and 99. On the whole, it can be observed that the companies up to 50 employees have a greater need to catch up in utilising formal property rights and in the service sector, also for strategic protection instruments. In the large enterprises, we observe rather efforts to use and combine their protection instruments more efficiently.

3 Reasons to Utilise Property Rights and Protection Mechanisms

In this section we want to investigate the question, which enterprise- and sector-specific characteristics determine the use of property rights and protection mechanisms.¹ For in section 2 it became clear that distinct differences exist between the branches, but also between the company size classes. In addition, further determining factors are included in the multivariate explanation of the utilisation behaviour.

3.1 Scope of Utilisation of Protection Mechanisms

In order to obtain an overview of the use of protection mechanisms, we firstly generate an index which measures the scope of use of the protection mechanisms and approximate the diversity of the portfolio of IP protection mechanisms in employed in the companies. The index reports how many of the eight mechanisms cited in the survey are applied by each company and thus has a range between 0% and 100%. We consider this indicator for all innovators and additionally for innovators who actively pursue a protection strategy for their intellectual property. The utilisation of at least one measure for IP appropriation serves us thereby as an indicator.

¹ Whereas the use of protection mechanisms in the cursory depiction in Section 2 is projected to total population of German enterprises, the analyses in the following sections are based on the un-weighted observations.

Table 3-1 Average Scope of Utilisation of Protection Measures acc. to Sectors

Manufacturing industry	N	Average scope for innovators	Share of innovators with protection strategy	Average scope for innovators with protection strategy
Mining	23	20%	57%	36%
Food	88	23%	60%	38%
Textiles	81	25%	69%	37%
Wood	218	21%	56%	37%
Chemicals	168	35%	85%	41%
Rubber	119	28%	71%	40%
Glass	58	30%	66%	46%
Metal	262	25%	64%	39%
Mechanical engineering	221	36%	85%	43%
Electrical engineering	194	34%	79%	43%
Instruments	203	38%	86%	44%
Vehicles	102	34%	78%	44%
Furniture	78	29%	72%	40%
Energy	92	11%	35%	30%
Building, construction	29	14%	55%	25%

Services	N	Average range for innovators	Share of innovators with protection strategy	Average range for innovators with protection strategy
Trade	38	12%	34%	34%
Wholesale trade	95	10%	34%	31%
Post	171	11%	40%	27%
Bank	180	12%	41%	31%
Real estate	39	13%	39%	33%
Computers	175	24%	70%	34%
Technical services	272	27%	71%	38%
Consulting	109	23%	64%	35%
Business services	147	10%	39%	26%
Media	33	22%	70%	32%

Table 3-1 presents the use of protection measures by innovators. Column 3 depicts the average scope of utilisation within innovating companies. In column 4 we find the share of innovators in the respective sector actively pursuing an IP protection strategy. Column 5 finally presents the scope of utilisation of IP appropriation mechanisms for enterprises which pursue an active protection strategy.

It shows that utilising protection measures in parallel is more widespread in manufacturing industries than in the service sectors. So, for example, in the manufacturing of medical and optical

instruments (NACE 33) on average around 38 % of the protection mechanisms are utilized, while in business services the average is only 10 %. Particularly widespread utilisation of protection mechanisms is found in the chemical industry, electrical engineering, motor vehicle industry and mechanical engineering. It can also be seen that the average utilisation range fluctuates less between the sectors, if only the enterprises are considered which actively pursue a protection strategy (column 4 in Table 3-1). If we at first assume that the protection strategies of companies manifest themselves in the scope of protection mechanisms applied, then we find relatively small differences in the strategies between the sectors, as soon as firms have decided to apply protection measures. If, for instance, firms offering technical services, computer services or firms from the consulting sector utilize means to protect their IP, then they utilise on average about three out of the eight types of measures (35 %-38 %) captured in the survey. In manufacturing industry, medical and optical instruments, and motor vehicles, the companies which pursue protection strategies employ on average between three or four of the protection mechanisms. A considerable part of the difference in the portfolio of protection mechanisms, as we observe in column 3 of Table 3-1, can be traced back to sectoral differences in the inclination of the companies whether to pursue protection strategies at all.

Table 3-2 Average Scope of Utilisation of Protection Measures acc. to Size Classes

Size classes	N	Average scope for innovators	Share of innovators with protection strategy	Average scope for innovators with protection strategy
Up to 49	1503	19%	55%	35%
50-99	430	23%	66%	35%
100-499	807	27%	71 %	38%
From 500	467	38%	80 %	48%

When observing different size classes, we also determine that the differences in the range of use grow smaller if only the companies which pursue any protection strategy at all are considered, i.e. those that apply at least one measure to protect their IP. Generally, it can be seen that with the innovators, the range of applied protection mechanisms also increases with the size of the enterprise. This increasing inclination to pursue an active protection strategy correlates with increasing company size. In the size classes up to 500 employees, the average scope of applied measures remains approximately constant for innovators with a protection strategy. Only in the size class above 500 employees do we find a clearly broader portfolio, with – on the average – around half of the protection mechanisms being applied.

3.2 Utilisation of Formal and Informal Protection Mechanisms

In order to gain further insight into the utilization of the IP protection mechanisms, we bundle similar IP protection measures together; i.e. whose utilization and appreciation are highly correlated. A factor analysis of all protection mechanisms bundles together the strategic and the formal (or legal) protection mechanisms based on their use and their appreciation. It is important to point out that the previously made and above discussed differentiation between formal and strategic protection mechanisms is not included in the analysis. The bundling of the measures purely derives from their usage and appreciation pattern. This bundling indicates therefore that the protection measures within the group of formal and strategic measures not only demonstrate conceptual and structural common features, but also that the innovators accord them a similar importance. With the formal protection measures it can usually be assumed that a department is responsible for all types of protection mechanisms and can thus realise synergies accordingly.

Table 3-3 Factor Analysis of the Importance of Protection Mechanisms

	Factor1	Factor2
Patents	0.6307	0.3623
Registered design	0.7207	0.2093
Industrial design	0.6619	-0.0144
Trademarks	0.6272	0.2221
Copyright	0.5959	0.114
Secrecy	0.2374	0.7947
Design complexity	-0.0229	0.7516
Lead time advantage	0.1851	0.8307
Significance	Formal	Strategic
	Protection Measures	

Remarks: rotated factor loadings. Criterion to extract the factors: eigenvalue >1.

The results of the factor analysis allow us to identify the protection mechanisms which demonstrate a similar, i.e. highly correlated relevance for the companies. The analysis allows for the generation of separate indices to rank formal and strategic protection measures. Positive values of this index indicate an above-average importance, whereas negative values point to below-average importance.

Table 3-4 Average Importance of Formal and Strategic Protection Mechanisms for Innovators acc. to Sectors

Manufacturing industry	N	Formal	Strategic
Mining	23	0.201	-0.169
Food	88	0.066	-0.230
Textiles	81	-0.124	0.272
Wood	218	-0.091	-0.232
Chemicals	168	0.243	0.458
Rubber	119	0.255	-0.079
Glass	58	0.341	0.055
Metal	262	0.106	0.005
Mechanical engineering	221	0.511	0.292
Electrical engineering	194	0.277	0.282
Instruments	203	0.157	0.611
Vehicles	102	0.572	0.270
Furniture	78	0.571	-0.166
Energy	92	-0.312	-0.463
Building, construction	29	-0.099	-0.521
Services	N	Formal	Strategic
Trade	38	-0.149	-0.592
Wholesale trade	95	-0.343	-0.454
Post	171	-0.314	-0.380
Bank	180	-0.392	-0.340
Real estate	39	-0.303	-0.461
Computers	175	-0.236	0.153
Technical services	272	-0.194	0.244
Consulting	109	-0.140	-0.070
Business services	147	-0.377	-0.445
Media	33	0.143	-0.178

Remarks: the sector labels in column 1 are to be interpreted as abbreviations, which summarise a class of NACE rev. 1.1 sectors, largely on the two digit level.

Figure 3-1 visualises the contents of Table 3-4. Formal and strategic protection measures have above-average importance for chemicals, instruments and optics, electrical engineering, mechanical engineering and vehicles. Both types of protection mechanisms have below-average importance for service sectors like bank and post services, real estate, business services, wholesale and retail trade and for the wood-processing industry as well as the construction industry. For technical services, the textile industry and computer services, strategic protection measures are of above-average relevance, but formal protection mechanisms on the other hand rate as below-average importance. Whereas in the rubber and plastic processing industry, furniture

industry, food and in the media, strategic protection mechanisms play a below average role, the formal protection measures on the other hand enjoy above-average importance.

Figure 3-1 Average Importance of Formal and Strategic Protection Measures for Innovators acc. to Sectors



3.3 Determinants for Utilisation of Protection Measures

In order to analyse the determinants for utilising protection measures, we shall proceed in two steps. Firstly, we analyse the reasons for the aggregated indicators of utilisation and the scope of protection strategies as presented in Sections 3.1 and 3.2. Then we shall analyse the utilisation or the significance of the eight individual protection measures included in the survey. However, we start with a section about hypotheses on the determinants for the use of protection measures.

3.3.1 Hypotheses

In a first step the existence of an active protection strategy, i.e. the utilisation of at least one protection measure, the scope of the protection strategy, i.e. the number of different protection

measures employed by the firm, and the importance of formal and strategic protection measures are regressed to exogenous factors. For the regression of the existence of a protection strategy a Probit model is estimated, the scope of the protection strategies is analysed by means of a negative binomial regression. As it can be assumed that the importance of the formal protection measures is not independent of the importance of the strategic protection measures, both will be simultaneously estimated by means of a *seemingly unrelated regression* model.

The regressions will include a number of exogenous company and sectoral characteristics. The company size will be included as the logarithm of the number of employees. The hypothesis related to this variable is that larger companies have advantages to bear the fix costs associated with all kind of protection measures. Furthermore, the large companies are able to exploit economies of scale and even economies of scope between the usage of different protection strategies.

The export share of turnover integrates the international orientation of the company in the regression. The export activity is also positively related with all types of protection mechanisms, because the threat of unintended knowledge and technology spill-overs increases if customers are located abroad. Solely having domestic customers would make it easier to establish close relations to customers, which would make protection mechanisms less necessary.

The innovation activities will be covered not only in their intensity – presented by the share of innovation expenditures in turnover – but also by the innovation goals. Again, the demand for protection instruments increases with the innovation intensity, because the output of these activities is a valuable asset for the companies securing their competitiveness (Brouwer, Kleinknecht 1999). Regarding the innovation goals, those related to product innovations are more likely to be protected at least by intellectual property rights, whereas process innovations can be more efficiently protected by informal protection strategies (Cohen et al. 2000).

The introduction on new knowledge management systems is also included. Units responsible for knowledge management facilitate at least the use of intellectual property rights, whereas the link to other protection strategies is rather weak.

As the utilisation of certain protection measures can be induced by innovation cooperation, the firm's collaboration activity will be broken down into vertical, horizontal and scientific collaborations. Vertical innovation cooperation describes those with suppliers or customers, horizontal innovation cooperation refers to the collaboration on innovations with competitors. Innovation collaborations with universities and research institutes are described as scientific collaboration. In general, intellectual property rights are used as assets in company collaborations both on the horizontal and vertical level. Previous studies, e. g. by Peeters and van Pottelsberghe (2006) assume and find positive relationships between the cooperation intensity in various dimension and the likelihood and the amount to use patents.

In contrast to other studies, we consider also various dimensions of competition more as control variables as in order to test elaborated hypotheses. We differentiate between the threat of new entry, the dynamics of process technology, the dynamics of new products respective services, easy substitution by competition and finally uncertain demand.

Besides company-specific factors, a number of sector-specific variables about the competitive environment of the sector on NACE 3-digit level are included in the analysis. Cohen et al. (2000) assume in their analysis that sector-specific aspects are relevant for the use of patents besides the differences in research and innovation intensities due to specific technological characteristics, whereas Blind et al. (2006) argue that sector-differences disappeared and size effects become much more dominantly.

3.3.2 Existence and Scope of the Protection Strategy

Based on the above postulated hypotheses, we performed a series of regressions. The results of the regressions are summarized in Table 3-5. The probability that firms will pursue a protection strategy increases significantly with the size of the enterprise. Equally, the size also exercises a positive influence on the scope of the protection strategy and the importance of the formal and strategic protection mechanisms. This result underlines that the utilisation of protection strategies entails significant fixed costs which can be more easily compensated for by larger companies through appropriate advantages. Furthermore, apparently synergies or complementarities exist between the utilisation of various protection instruments. The international orientation of a company positively influences the scope of the strategy and the importance of the protection measures. This indicates that under certain circumstances different strategies must be pursued, as the intellectual property regimes in the different foreign markets, but also their implementation, are not harmonised. Enterprises with higher innovation intensity exhibit a greater propensity to pursue a protection strategy, in the same way the strategies themselves have a larger scope. The importance of both types of protection measures increases with innovation intensity. If one assumes that the innovation intensity approximately reflects the level of knowledge-generating activities in the firm, then the artefacts generated within the framework of these activities are the objects which the protection strategies refer to. A higher intensity leads therefore in anticipated manner to a greater probability and a broader scope of the protection strategies, in order to better appropriate the returns from the innovation activities.

Basic pre-requisite for introducing knowledge management systems is the recognition on the one hand that knowledge is an important, if not even the most important resource for the success of an enterprise and that knowledge although often *tacit* and not codified, is also manageable, on the other hand. The introduction of new knowledge management systems generally leads in companies to better and codified knowledge flows within the company. The protection of this knowledge requires broadly oriented protection strategies and as a rule is only achieved via the

protection mechanisms subsumed here under strategic measures. For, as mentioned above, the formal protection mechanisms implicitly lead to – even if delayed – disclosure of the protected knowledge. This surprising result therefore suggests that the organisational unit responsible for knowledge management does not necessarily concern itself with the management of intellectual property rights.

With the growing relevance of product- or service-related innovation strategies, the probability of pursuing protection strategies also increases significantly. In the same way they lead to a broader orientation of the strategies and a greater importance of the strategic protection mechanisms. The meaning of formal protection mechanisms such as patents and trademarks are not influenced by product-related innovation strategies. It is equally seen that process-related innovation strategies exercise a positive influence on the significance of the strategic protection measures. This result does not confirm earlier studies, e. g. by (Cohen et al. 2000), who showed for manufacturing industry that patents have a greater importance for the protection of product innovations, while informal protection strategies are more efficient for the protection of process innovations. This contradiction can be explained by the fact that we have also included service sectors in our investigation whose product innovations cannot necessarily be safeguarded by formal protection measures.

Vertical and horizontal innovation cooperation increases the probability that a protection strategy will be implemented, and scope of the instruments used. The results of other studies confirm this, (Peeters, van Pottelsberghe de la Potterie 2006). Innovation collaboration with suppliers or customers has a positive effect on the assessment of the importance of strategic protection mechanisms; collaboration with competitors leads however to enterprises estimating the importance of formal protection mechanisms more highly. This supports the hypothesis that intellectual property rights, in particular patents, are becoming increasingly important in negotiations between firms (Blind et al. 2006). Cooperation with scientific institutions shows the same pattern of influence as cooperation with customers and suppliers do. The knowledge gained through cooperation with suppliers, customers or scientific institutions should be protected from competitors, strategic protection measures usually suffice, from the enterprises' perspective. Additional formal protection mechanisms must be employed in cooperations which include competitors. In sectors threatened by the entry of new companies, strategic protection measures appear to be more significant than in sectors which are less threatened by the advent of new competitors. This result can at least be regarded as an indication that formal protection rights are not necessarily employed to seal off markets. Strategic protection measures can be an essential part of strategies to prevent entry into markets.

In sectors with great dynamic in the technological processes, in other words in sectors where the production technologies rapidly grow obsolete, significantly narrower/ closer protection strategies are implemented than in sectors with slower process technology dynamics. Conversely, it

appears that in sectors characterised by a high dynamic in products and services, the probability of protection strategies and their scope increases. Formal protection mechanisms are gaining in importance in these sectors also. According to the enterprises, they offer the possibility to appropriate innovation returns in these sectors, despite short product life cycles. In sectors with an uncertain demand situation, formal protection mechanisms have a significantly lower importance.

On the whole, the analysis shows that not only the innovation cooperation, the competitive conditions in the sector and the sectoral affiliation of the firm have a joint significant influence on the probability of implementing a protection strategy, the scope of a protection strategy and the significance of the formal and the strategic protection mechanisms.

Table 3-5 Determinants of Utilisation and Importance of Protection Measures

	Protection strategy	Scope of protection strategy	Importance of formal protection measure	Importance of strategic protection measure
Size (log of employees)	0.179*** <i>0.02</i>	0.125*** <i>0.012</i>	0.149*** <i>0.014</i>	0.066*** <i>0.013</i>
Export share of turnover	0.113 <i>0.082</i>	0.124** <i>0.054</i>	0.154*** <i>0.058</i>	0.112** <i>0.056</i>
Innovation intensity	2.148*** <i>0.457</i>	0.784*** <i>0.141</i>	0.314* <i>0.189</i>	1.013*** <i>0.182</i>
Introduction of new knowledge management system	0.116* <i>0.064</i>	0.130*** <i>0.039</i>	0.009 <i>0.044</i>	0.166*** <i>0.043</i>
Innovation goal: product-related	0.409*** <i>0.066</i>	0.287*** <i>0.044</i>	0.077 <i>0.047</i>	0.271*** <i>0.045</i>
Innovation goal: process-related	0.028 <i>0.066</i>	0.053 <i>0.04</i>	-0.005 <i>0.046</i>	0.102** <i>0.044</i>
Innovation cooperation: vertical	0.201* <i>0.118</i>	0.155*** <i>0.056</i>	0.110 <i>0.071</i>	0.292*** <i>0.068</i>
Innovation cooperation: horizontal	0.580*** <i>0.154</i>	0.135** <i>0.06</i>	0.222*** <i>0.078</i>	-0.02 <i>0.075</i>
Innovation cooperation: scientific	0.381*** <i>0.119</i>	0.168*** <i>0.057</i>	0.111 <i>0.074</i>	0.196*** <i>0.071</i>
Competition. threat of new entry	-0.066 <i>0.227</i>	0.181 <i>0.152</i>	-0.003 <i>0.168</i>	0.300* <i>0.161</i>
Competition. dynamic of techn. process	-0.328 <i>0.253</i>	-0.282* <i>0.171</i>	-0.270 <i>0.183</i>	0.131 <i>0.176</i>
Competition. dynamic of new prod./services	1.320*** <i>0.299</i>	0.984*** <i>0.193</i>	0.859*** <i>0.207</i>	0.080 <i>0.199</i>
Competition. easily substituted	0.245 <i>0.237</i>	-0.050 <i>0.159</i>	0.152 <i>0.168</i>	-0.206 <i>0.161</i>
Competition. uncertain demand	0.063 <i>0.267</i>	-0.238 <i>0.172</i>	-0.395** <i>0.194</i>	0.067 <i>0.186</i>
LR (cooperations)	53.85***	45.50***	91.12***	69.23***
LR (competition)	21.96***	35.29***	25.18***	22.34***
LR (sector)	86.76***	135.02***	141.72***	134.42***
Number of observations	2364	2364	1917	1917
(Pseudo) R2	0.246	0.094	0.201	0.246
Chi2	746.05***	821.78***	483.18***	625.00***

Remarks: ***, **, * give the significance to the 0.1%, 1%, 5% level. Standard error are in *italics*. The analyses contain also 26 sector dummies, which are not presented here. The common significance of the cooperation variables, the competition variables and the sector dummies is explicitly pointed out.

3.3.3 Utilisation and Importance of Formal Protection Measures

In the next step, the determinants of the single protection measures are investigated. For this, firstly the utilisation and importance of the formal protection mechanisms on the exogenous

factors are regressed, whereby the analysis exclusively considers patents, trademarks and assertion of copyrights, as utility models are only used by a very small number of companies. Then all strategic protection mechanisms are also separately regressed to the exogenous company and sectoral characteristics. As the data for the utilization and the importance of protection mechanisms is presented in a four-step Likert scale with the rankings *no utilisation*, *low importance*, *middling importance* and *great importance*, we speak in the following of utilisation and importance of the protection mechanisms and analyse them by means of an *ordered Probit* model.

Table 3-6 Determinants of Utilisation and Importance of Formal Protection Measures

	Patents	Trademarks	Copyright
Size (log of employees)	0.262*** <i>0.022</i>	0.160*** <i>0.019</i>	0.107*** <i>0.024</i>
Export share of turnover	0.349*** <i>0.094</i>	0.150* <i>0.085</i>	0.050 <i>0.112</i>
Innovation intensity	1.865*** <i>0.251</i>	0.710*** <i>0.228</i>	0.560** <i>0.285</i>
Introduction of new knowledge management system	-0.039 <i>0.067</i>	0.034 <i>0.063</i>	0.155* <i>0.081</i>
Innovation goal: product-related	0.220*** <i>0.073</i>	0.224*** <i>0.069</i>	0.122 <i>0.092</i>
Innovation goal: process-related	0.049 <i>0.068</i>	-0.008 <i>0.065</i>	0.105 <i>0.085</i>
Innovation cooperation: vertical	0.132 <i>0.092</i>	0.152 <i>0.094</i>	-0.003 <i>0.122</i>
Innovation cooperation: horizontal	0.262** <i>0.102</i>	0.216** <i>0.099</i>	0.099 <i>0.127</i>
Innovation cooperation: scientific.	0.385*** <i>0.092</i>	0.062 <i>0.098</i>	0.215* <i>0.122</i>
Competition. threat by new entry	0.154 <i>0.262</i>	-0.094 <i>0.237</i>	-0.108 <i>0.324</i>
Competition. dynamic of process techn.	-0.316 <i>0.295</i>	-0.576** <i>0.28</i>	-0.529 <i>0.372</i>
Competition. dynamic of new prod./serv.	0.491 <i>0.337</i>	1.575*** <i>0.313</i>	1.781*** <i>0.419</i>
Competition. easily substituted	-0.059 <i>0.28</i>	0.154 <i>0.247</i>	0.017 <i>0.335</i>
Competition. uncertain demand	-0.523* <i>0.293</i>	-0.381 <i>0.271</i>	-0.834** <i>0.365</i>
LR (cooperations)	61.43***	17.88***	6.65
LR (competition)	4.89	30.65***	24.03***
LR (sectors)	324.01***	73.28***	74.70***
Number of observations	2226	2167	2124
(Pseudo) R2	0.253	0.088	0.090
Chi2	970.37***	302.79***	163.82***

Remarks: ***, **, * give the significance to the 0.1%, 1%, 5% level. Standard errors are in *italics*. The analyses also contain 26 sector dummies which are not presented here. The common significance of the cooperation variables, the competition variables and the branch dummies are explicitly pointed out.

Table 3-6 summarises the *ordered Probit* regressions to determine the factors influencing the utilisation and importance of formal protection mechanisms. Basically, the explanatory power of the models is by far the strongest in the case of patent utilisation. In the following discussion, we deal with significant differences between the models with regard to the explanatory factors in more depth.

As already in the previous analysis, company size positively influences the utilisation and importance of all facets of formal protection mechanisms. In the context of internationally oriented companies, patent protection and trademark protection are more frequently sought than by firms operating rather at a national level. Copyright is not necessarily perceived as an efficient form of protection in an international context. Innovation intensity also exercises a positive influence on all formal protection mechanisms. The introduction of knowledge management systems appears to influence only the appreciation of copyrights, synergies with patent departments are not discernible. In contrast to the process-oriented innovation strategies, which exercise no influence on the formal protection mechanisms, we find higher utilisation and importance of patents and trademarks in enterprises with distinctly product-related innovation strategies. Innovation cooperations with competitors lead to an increasing importance of patents and trademarks, whereas copyright is obviously not efficient enough. Innovation collaboration with scientific institutions has a positive effect on the importance of patents and copyrights. While the traditional publication activities of the scientific institutions explain the positive influence on the utilisation of copyrights, in the meantime their increasing patenting activities are also reflected in the patent applications of the enterprises. On the other hand, collaboration with customers and suppliers has no influence on the utilisation and importance of the formal protection mechanisms.

In sectors with strong dynamics in production technologies, we find a lower propensity to use all formal protection measures, whereby merely the effect on utilisation and the importance of trademarks is significant. High sectoral dynamics in the obsolescence/ ageing of products and services leads to increased utilisation and growing importance of all facets of formal protection mechanisms, whereby the effect on patents is however not significant. Here the lengthy procedure compared to trademark applications and informal copyright protection is reflected.

Whereas the easy substitution of competitive products does not influence the utilisation of formal protection rights, from the enterprise perspective they offer a possibility to protect rather product-related knowledge from competitors and to safeguard the innovation returns for given or certain demand. Generally, the connection between product or service and the utilisation of formal protection mechanisms is evident in the results of the regression models, whereby the differences in the protection rights is also reflected in the utilisation behaviour of the enterprises.

3.3.4 Utilisation and Importance of Strategic Protection Measures

The analysis in this section is similar to the procedure in Section 3.3.3. The utilisation and importance of the strategic measures are regressed to the exogenous enterprise-specific and sector-specific factors.

Table 3-7 Determinants of the Utilisation and Importance of Strategic Protection Measures

	Secrecy	Complexity	Lead time advantages
Size (log of employees)	0.134*** 0.018	0.018 0.020	0.108*** 0.018
Export share of turnover	0.220*** 0.079	0.03 0.090	0.136* 0.079
Innovation intensity	1.266*** 0.253	0.657*** 0.25	1.157*** 0.26
Introduction of new knowledge management system	0.195*** 0.059	0.317*** 0.065	0.177*** 0.059
Innovation goal: product-related	0.305*** 0.063	0.296*** 0.074	0.450*** 0.063
Innovation goal: process-related	0.071 0.060	0.160** 0.068	0.154** 0.061
Innovation cooperation: vertical	0.202** 0.089	0.171* 0.098	0.357*** 0.093
Innovation cooperation: horizontal	0.069 0.098	-0.103 0.108	0.104 0.103
Innovation cooperation: scientific.	0.382*** 0.090	0.206** 0.101	0.117 0.094
Competition. threat by new entry	0.180 0.224	0.698*** 0.264	0.365 0.224
Competition. dynamics of techn. process	0.171 0.244	-0.127 0.283	0.063 0.241
Competition. dynamics of new prod./services	0.363 0.277	0.421 0.316	0.425 0.278
Competition. easy substitution	-0.330 0.229	-0.244 0.265	-0.109 0.23
Competition. uncertain demand	0.083 0.259	0.016 0.305	-0.061 0.259
LR (cooperations)	53.82***	13.34***	37.99***
LR (competition)	8.02	10.27	7.50
LR (sectors)	130.51***	37.44	101.52***
Number of observations	2115	2071	2090
(Pseudo) R2	0.141	0.062	0.120
Chi2	618.56***	184.46***	493.20???

Table 3-7 summarises the determining factors for the utilisation and importance of strategic protection mechanisms. We only discuss the differences between the models in more detail.

It appears that with the exception of design complexity, the strategic measures gain in importance with the size of the enterprise. Obviously, size advantages exist on the cost side and above all the benefit side, not only in the realisation of secrecy, but also in first mover advantages.

Complex product design is an efficient protection strategy for small firms also. Equally, complexity does not depend on the international orientation of the company, unlike secrecy and realising first mover advantages. As with the formal measures, the innovation intensity influences the utilisation and importance of all strategic protection measures positively. The introduction of new knowledge management systems leads to greater utilisation and appreciation of all facets of the strategic protection measures. Product-related innovation strategies lead to increased utilisation and higher assessments of all strategic measures to protect IP. On the other hand, process-related innovation strategies induce more intensive utilisation of complexity in design and of lead time advantage, while secrecy is not an efficient measure. As opposed to horizontal innovation cooperation, in which the firms safeguard themselves by means of formal property rights, vertical innovation collaboration leads to utilising all strategic protection measures. Cooperation with scientific institutes also impacts positively on the use and significance of all strategic measures, whereby the effect on utilising a lead time advantage ahead of competitors is not significant. The utilisation of design complexity is more widespread in sectors which are badly threatened by (new) entry of competitors than in sectors with little threat of this happening.

As with the formal protection mechanisms, one finds a strong influence of the innovation cooperation on the utilisation and importance of all strategic protection mechanisms. Sector membership can neither individually nor jointly explain the utilisation and importance of design complexity as a protection mechanism. Secrecy and lead time advantage are however together significantly explained by sectoral affiliation. Equally, the companies' competitive environment shows no influence on the utilisation and importance of strategic mechanisms in the corresponding branch.

The lack of explanations found in sectoral variables indicates that the use of strategic protection mechanisms and their importance are characterised above all by enterprise-specific determinants. Besides the size of the company and the innovation intensity, the entire strategic orientation of the company is of paramount relevance for utilising strategic protection measures. The utilisation and importance of strategic protection measures is therefore to be regarded in close connection with the direction and the intensity of innovation strategies and the internal management of strategic resources for the innovation process.

4 Summary

The comparative analysis of factors determining the use of protection instruments confirms previous results, but also reveals new insights.

First, larger companies use all instruments more intensively, not only formal intellectual property rights. Consequently, small and medium sized companies experience disadvantages in all protection instruments and challenge policy makers and existing support schemes.

Second, companies with higher innovation intensity are more likely to use all types of protection instruments and not only the formal protection rights. The challenge is to consider also support schemes for the informal protection strategies.

Companies involved in export activities have special focus on patents as the strongest protection right. The question is whether other instruments can be used more effectively also by exporters. Interestingly, the various cooperation activities have different implications for the use of protection strategies. Cooperations on the vertical level are more likely to lead to strategic protection measures, whereas the more sensitive horizontal cooperations require the stronger formal intellectual property rights. The new insights regarding the influence of the competitive circumstances require further analyses.

5 Literature

- Allegrezza, S.; Guard-Rauchs, A. (1999): The determinants of trademark deposits: an econometric investigation. In: *Economie Appliquée*, 52 (2), pp. 51-68.
- Arundel, A. (2001): The relative effectiveness of patents and secrecy for appropriation. In: *Research Policy*, 30, pp. 611-624.
- Blind, K.; Edler, J.; Friedewald, M. (2005): *Software Patents: Empirical Evidence and Policy Implications*, Cheltenham: Edward Elgar.
- Blind, K.; Edler, J.; Frietsch, R.; Schmoch, U. (2006): Motives to patent: empirical evidence from Germany. In: *Research Policy*, 35, pp. 655-672.
- Blind, K.; Edler, J.; Frietsch, R.; Schmoch, U. (2004): Scope and Nature of the Patent Surge: A View from Germany. In: *Patents, Innovation and Economic Performance*. Paris: OECD, pp. 83-88.
- Brouwer, E.; Kleinknecht, A. (1999): Innovative output and a firm's propensity to patent. An exploration of CIS micro data. In: *Research Policy*, 28, pp. 615-624.
- Cohen, W.; Nelson, R.R.; Walsh, J. (2000): Appropriability Conditions and Why Patent and Why They Do Not, National Bureau of Economic Research, Working Paper 7552, Washington D.C.: NBER.
- Cohen, W.M.; Goto, A.; Nagata, A.; Nelson, R.R.; Walsh, J.P. (2002): R&D spillovers, patents and the incentives to innovate in Japan and the United States. In: *Research Policy*, 31, pp. 1349-1367.
- Graham, S.; Mowery, D.C. (2003): Intellectual property protection in the US software industry. In: *The Patent System in the Knowledge-based Economy*. Cohen, W.; Merrill, S. (eds.). Washington: National Academies Press.
- Hoppe, H.C.; Lehmann-Grube, U. (2001): Second-mover advantages in dynamic quality competition. In: *Journal of Economics & Management Strategy*, 10 (3), pp. 419-433.
- Hussinger, K. (2006): Is Silence Golden? Patents versus Secrecy at the Firm Level. In: *Economics of Innovation and New Technology*, 15 (8), pp. 735-752.
- Kerin, R.A.; Varadarajan, P.R.; Petereson, R.A. (1992): 1ST-MOVER ADVANTAGE - A SYNTHESIS, CONCEPTUAL-FRAMEWORK, AND RESEARCH PROPOSITIONS. In: *Journal of Marketing*, 56 (4), pp. 33-52.
- Lambert, D.; Slater, S.F. (1999): First, fast, and on time: The path to success. Or is it? In: *Journal of Product Innovation Management*, 16 (5), pp. 427-438.
- Levin, R.; Klevorick, A.; Nelson, R.; Winter, S. (1987): Appropriating the returns from industrial research and development. In: *Brookings Papers on Economic Activity*, 3, pp. 783-820.

- Lilien, G.L.; Yoon, E. (1990): The Timing of Competitive Market Entry: An Exploratory Study of New Industrial Products. In: *Management Science*, 36 (5), pp. 568-585.
- Mansfield, E. (1986): Patents and innovation: an empirical study. In: *Management Science*, 32, pp. 173-181.
- Peeters, C.; van Pottelsberghe de la Potterie, B. (2006): Innovation strategy and the patenting behavior of firms. In: *Journal of Evolutionary Economics*, 16, pp. 109-135.
- Rammer, C. (2003): Patente und Marken als Schutzmechanismen für Innovationen, Nr. 11-2003, Studien zum deutschen Innovationssystem, Bonn: Bundesministerium für Bildung und Forschung.
- Schmoch, U. (2002): Marken als Innovationsindikator, Fraunhofer-Institut für Systemtechnik und Innovationsforschung (ed.): Bundesministerium für Bildung und Forschung.
- Schmoch, U. (2003): Service Marks as Novel Innovation Indicator. In: *Research Evaluation*, 12 (3), pp. 149-156.
- Stolpe, M. (2000): Protection against software piracy: a study of technology adoption for the enforcement of intellectual property rights. In: *Economics of Innovation and New Technology*, 9, pp. 25-52.
- Vakratsas, D.; Rao, R.C.; Kalyanaram, G. (2003): An empirical analysis of follower entry timing decisions. In: *Marketing Letters*, 14 (3), pp. 203-216.
- VanderWerf, P.A.; Mahon, J.F. (1997): Meta-analysis of the impact of research methods on findings of first-mover advantage. In: *Management Science*, 43 (11), pp. 1510-1519.