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The Influence of Strategic Patenting on Companies' Patent Portfolios

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Non-technical Summary

The role of patents changed fundamentally in the 1990s. The number of patent applications increased notably faster than companies' R&D expenditures, even though companies attributed a decreased role to patents in protecting innovations. Patents gained a strategic importance that exceeded their traditional role of appropriating direct returns from R&D. Patenting has been motivated by the desire to block competitors in their research activities (blocking motive). In addition, patents have become important assets in R&D collaborations, to generate licensing revenues or to enter cross-licensing agreements (exchange motive). It has been assumed that, alongside the traditional protection motive, these additional strategic motives have an influence on the characteristics of companies' patent portfolios. However, no insights into this relationship have been available until now.

This paper analyses whether strategic motives for patenting influence the characteristics of companies' patent portfolios. As first characteristic we use the average number of citations that the patents in a portfolio receive. The number of citations can be interpreted as a value indicator. The more citations a patent receives from later patent applications the higher its value. The second characteristic is the share of patents in a portfolio that receive an opposition. Within nine months after the grant of a patent by the European Patent Office (EPO), any third party can file an opposition against it. In an opposition proceeding the validity of a patent is checked.

The investigation is based on survey data from more than 400 German companies that was combined with patent information from the EPO. There is evidence that the patenting strategies of companies help to explain the characteristics of their patent portfolios. First, companies that use patents in their traditional function of protecting innovations from imitation receive, on average, a higher number of citations for their patents than companies that emphasise the more strategic motives of blocking and exchange. Interpreting the number of citations as an indicator of value, we find that strategic motives lead to patents of lower value. This finding is of great importance to policy makers who are concerned that an increasing number of patents of low value may lead to patent thickets that could hinder innovation. Second, we find that the motive of offensive blocking but not of defensive blocking is related to a higher incidence of oppositions, whereas companies emphasising the exchange motive receive fewer oppositions to their patents. Obviously, companies which collaborate in R&D or cross-license patents on a regular basis may try to avoid patent conflicts or may prefer to resolve such conflicts informally.

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- FORTHCOMING: RESEARCH POLICY -

Abstract

This paper analyses whether strategic motives for patenting influence the characteristics of companies' patent portfolios. We use the number of citations and oppositions to represent these characteristics. The analysis is based on survey data from German companies, which are combined with EPO data covering applications from 1991 to 2000. We find clear evidence that the companies' patenting strategies are related to the characteristics of their patent portfolios. First, companies using patents in the traditional way to protect their technological knowledge base receive a higher number of forward citations for their patents. Second, the motive of offensive – but not of defensive – blocking is related to a higher incidence of oppositions, whereas companies using patents as bartering chips in collaborations receive fewer citations and fewer oppositions to their patents.

JEL: O 34, O 32

Keywords: strategic patenting, patent portfolio characteristics

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1 Introduction

One phenomenon of the 1990s that was observed in several European countries, and also the USA and Japan, was a strong increase in patent applications. At the same time, private expenditure on R&D grew only modestly. Consequently, the patent intensity, defined as patent applications per unit of R&D expenditure, increased significantly (Blind et al. 2004). In this context, several authors (Jaffe, Lerner 2004; Shapiro 2003) highlight the innovation-hindering effect of patents. Several explanations for this phenomenon are provided in the literature, although none can claim to be able to explain the whole story (Jaffe 1999). First, it is argued that the R&D process became more efficient or more differentiated by a further division of labour, leading to a higher number of inventions and therefore of patents per unit of R&D expenditure (Janz et al. 2001). Second, patent applications have been extended to promising and expanding new fields of technology (Kortum, Lerner 1999), like biotechnology (e.g. Thumm 2003) and software (e.g. Blind et al. 2005). Third, patent strategies have changed and became more complex and comprehensive, leading to an expansion of patent applications (Blind et al. 2004).

The first explanation does not provide a source for concern and the second involves external technological or political forces, which cannot be dealt with in one single paper. Accordingly, our analysis focuses on the third. A number of previous studies present structures and the extent of strategic patenting (Arundel et al. 1995; Cohen et al. 2002; Schalk et al. 1999). They argue that the patent system, the original purpose of which was the temporary protection of a company's technological knowledge base, is used by companies for various other so called "strategic" motives. For example, patents are also an instrument for securing one's own future technological space against competitors or for restricting competitors' future technological opportunities. In recent years, patents have become important assets in collaborations, to generate licensing revenues or to get better access to the capital market, especially by indicating a sound basis of a business model in the case of start-up companies. Finally, patents can also be used by companies' management as a performance indicator and even linked to reward schemes for researchers.

Parallel to the emerging literature on strategic patenting, numerous authors have concentrated on the analysis of indicators to determine the economic value of patents. In bibliographic analyses, the number of citations is accepted as a reliable value indicator. It can be successfully transferred to patents.[1] Furthermore, cases of patent oppositions

[1] See Lanjouw and Schankerman (2004) for a comprehensive overview.

are a good signal that a patent is valuable. Several studies have looked into both the interrelationship of various indicators of patents and their explanatory power for their monetary value (Harhoff et al. 2003; Harhoff, Reitzig 2004; Lanjouw, Schankerman 2004; Trajtenberg 1990).

In our paper, we try to contribute to bridge the gap between the research on strategic patenting and analyses of companies' patent portfolios. Peeters and van Pottelsberghe (2006) already address the relationship between companies' innovation strategies and their patent portfolios, whereas Hall et al. (2007) analyse the relation between firms' stock market value, patents, and "quality"-weighted patents with a specific focus on software patents. Like the latter, we focus explicitly on the characteristics of a company's portfolio and not on single patents. We extend the systematic analysis of factors explaining the motives of strategic patenting in Germany by Blind et al. (2006). Our aim is to analyse the relationship between strategic patenting and the characteristics of companies' patent portfolios, measured by various indicators. This paper is based on survey data collected by Blind et al. (2003) from a sample of almost 500 patenting companies in Germany. The data were matched with the EPO application data during the period of 1991-2000. Especially the forward citations and the opposition data were combined with the survey information. We present insights into the influence of strategic patenting on the characteristics of companies' patent portfolios, indicated by the number of citations per patent and the likelihood of opposition.

Using this comprehensive database, we perform numerous multivariate regressions leading to the following insights. There is strong evidence that the motive structure affects the results of the patent examination process, i.e. references to other patent claims, or the opposition behaviour towards other applicants. We find that the more intensively companies use patents to achieve a protection objective, the higher is the average number of citations their patent portfolio receives. Conversely, in cases where strategic motives, such as blocking and exchange, dominate, portfolios receive less citations. Furthermore, our results show that the probability of opposition against a company's portfolio is higher, when the company assesses the offensive blocking motive as important. This implies that competitors also understand this motivation and are more likely to react with disputes against those companies. Simultaneously, companies that regard their patent motives mostly as driven by cooperation and exchange are faced with proportionally less oppositions to patents in their portfolios than companies using patents mainly for protective reasons. These insights also allow us to derive recommendations for future patent policy. Furthermore, an observed offensive blocking strategy results in frequent oppositions and rather limited citations of a company's patent portfolio. Such a strategy could also lead to "patent thickets", generating higher costs for innovating competitors. Whether policy makers should react to this anticompetitive behaviour depends on the extent of these thickets and their implications for further inventions.

The remainder of the paper is structured as follows. In Chapter 2 we discuss several patenting motives. In Chapter 3 we present the most relevant indicators for measuring the characteristics of patents. In Chapter 4 we develop a set of hypotheses for the empirical analysis of the relationship between different strategic motives for patenting and the characteristics of patent portfolios. Chapter 5 presents the merged database we use for our empirical analysis and some descriptive statistics. In Section 6, the results of a series of regressions are displayed and used to validate or revise the hypotheses developed in Chapter 4. The paper concludes with a summary of results and challenges for future research.

2 Motives to Patent

Different approaches can be taken to classify strategic motives to patent. The basic function of a patent as originally intended by the architects of the patent system is to provide an effective instrument to prevent imitation by competitors, in order to secure earnings from innovative technologies for the inventor, and cover his expenses. Thus, if this is achieved, patents should increase the incentive to invest in innovative activities. However, the patent system also creates opportunities to use patents for different, and in some cases related, purposes. Motives for patenting vary among patentees. There is no agreed definition of strategic patenting, although most experts include the use of patents to block competitors and the use of patents in negotiations with other companies.

Arundel and Patel (2003) divide these strategic (in contrast to traditional) reasons into defensive and offensive strategies. A firm will patent defensively in order to stop other firms from patenting one of its inventions and suing it for infringement, even though the firm does not need a patent on the invention to earn a return on its investments in innovation.[2] Other approaches refer mainly to the function of patents to block other market participants from using technologies which are protected by patents but not necessarily used in business. This strategy can be intended from the beginning of the patent application process or can emerge from the fact that certain patents are not worth exploiting but only used to build a protected area around other patents of the company. Firms patent offensively to prevent or block other firms from patenting inventions that are similar, but not identical, to the invention that they plan to commercialise. In this

[2] The returns derived from non-patent appropriation methods such as secrecy or lead-time advantages, which are also defensive in character, have consistently been shown in innovation surveys to be more valuable to firms than patents (Arundel et al. 1995; Cohen et al. 2000; Granstrand 1999). For analyses of the relationship between patenting and secrecy see for example Arundel (2001) and Hussinger (2006).

case, the firm builds a much broader patent wall – compared to defensive patenting – around its invention. This prevents other firms from commercialising competing products, even though the firm does not intend to market or license these other products itself.

Furthermore, firms may choose to patent defensively in order to generate revenue from or trade with other firms. In some sectors, such as information and communication technologies, the use of patents in negotiations with other firms for technology access is probably one of the most important motives for patenting (Hall, Ziedonis 2001). This trading or cooperation argument is strengthened by Noel and Schankerman (2006) who found that a large patent portfolio enhances the bargaining power of a company. Negotiations about mergers, license contracts, or research co-operations depend mainly on how the partners evaluate the research efforts and results of their counterparts, which is mainly measured in the number of patents in the companies' portfolio.

In the empirical literature, Blind et al. (2006) are able to divide the various motives for patenting into the traditional protection motive, the blocking motive, the reputation motive, the exchange motive, and the motive to use patents as incentives and as performance indicators for R&D departments and employees. This distinction is based on a factor analysis, which condenses the complex multiplicity of motives in a meaningful manner. The groups generated by the factor analysis correspond very well to the motive clusters discussed in the literature.

3 Patent Portfolio Characteristics

Patents are heterogeneous in their value and function for their owners and supply different levels of additional profit to companies through the original protection function and strategic functions (Somaya 2003). The value a single patent has for its patentee is not observable. Even the absolute value of patent portfolios or patent stocks is hard to identify from survey data (Harhoff et al. 2003). A comprehensive overview of patent value indicators is provided by Sapsalis and Pottelsberghe (2007). They relate their paper to the contributions of Schankerman and Pakes (1986) and Harhoff et. al. (1999). In this section, we present the most reliable indicators which can be used to describe the characteristics of a company's patent portfolio.

At the European Patent Office (EPO) the examiner makes the ultimate decision on what patents will be included as references to the prior art related to the submitted application. The patent applicant may suggest patents that should be included as references. The references to earlier patents in the German and European patent system mark the boundaries of patentability and the basis the invention builds on. They are

used to substantiate the patentability for which novelty and inventive activity are necessary. This function of citations implies that the number of citations received (forward citations) play a similar role to that of references in scientific publications as an indicator for the importance of the patent. Trajtenberg (1990) strongly supports this argument and Harhoff et al. (2003) provide broader evidence of the correlation between patent value and citations received in subsequent patent applications. However, one has to mention that citations can point to further technological development and a possible depreciation of the invention.

In addition to the number of citations, the incidence of an opposition is also a positive value indicator. Opposition is the first dispute about the validity of a granted patent. Any third party can file an opposition within nine months after a patent has been granted when there are reasons such as doubts as to novelty, doubts over a sufficient inventive step or when there might be pre-granting use of the invention prior to the patent application. The procedure is relatively cheap compared to a litigation procedure. However, there is no direct communication between the patentee and the opponent. This is different to a litigation procedure at a civil court. The rationale behind opposition is that the expected value of the protected invention is so high that it is worthwhile for competitors to oppose the patent in order to prevent or restrict the patentee's intellectual property right. Expected innovation rents for patents that withstood opposition procedures either amended or unchanged are proved to be higher than for non-opposed patents (Harhoff et al. 2006). This finding is strengthened by the analysis by Harhoff and Reitzig (2004), which shows that opposed EPO patents in biotechnology and pharmaceuticals are generally more valuable than those that were not opposed, based on measurements using several value indicators. On the one hand, a higher expected value of a patent attracts more interest from those who would wish to exploit that value. On the other hand, a patent that has faced and survived opposition becomes more valuable because survival indicates a stronger patent right. The fact that a patentee faces an opposition is a signal from potential or actual competitors. It reveals that the invention has been recognized to be relevant for other actors in the market and that they take the patent seriously. The result of those oppositions can be a rejection of the opposition or an amendment of the patent, both of which are considered to improve the quality of the patent. Amendments in the sense of restrictions to the original claims are also regarded as a quality check (Graham et al. 2003).

In the literature there are further indicators proved to be correlated with the value of the patent. In addition to the citation and opposition measure used in our empirical analysis, for completeness, the following four indicators have to be mentioned: references, family size (Putnam 1996), number of claims and routes of patent protection. However, we concentrate on citations and oppositions more as main characteristics than as value indicators of companies' patent portfolios in our analysis.

4 Hypotheses

We focus on three main clusters of patenting motives and relate these to the selected indicators for the characteristics of companies' patent portfolios: the original protection motive, the blocking motive and the exchange motive. The blocking motive is further divided into defensive and offensive blocking. Due to the special research question related to the two most important indicators the strategic motives are reduced and defined differently from that used by Blind et al. (2006). The exchange motive is defined in a narrower sense by just focusing on the use of patents for cross-licensing, for earning licensing revenues and to improve the company's own position in co-operations with other companies.

In order to analyse the influence of the various motives to patent on the characteristics of the patented innovation we explain the average number of citations per patent in companies' patent portfolios by the expressed priorities of the companies' patenting motives. If the protection of the technological knowledge base via patenting is very important compared to the strategic motives to patent, we can assume that the protected know-how is rather important, which should be reflected in a higher number of citations of the patents. A similar argument is valid for the motive of securing market share via patenting. In contrast, the research and development activities of competitors can be blocked by patents of rather mediocre quality. Furthermore, blocking competitors is more successful if competitors are confronted with just a higher number of patents claiming different aspects of the same technology. Consequently, the average quality of patents is likely to be lower if they are used to implement a blocking strategy.

In addition, the intention to block relates to future technological fields which may or may not be as important as anticipated. The uncertainty increases even further if a company applies for patents based on speculations about the possible future technological trajectories of its competitors, as in the case of offensive blocking. Defensive blocking is concentrated on the technological fields, which are very close to the core technological area of the company and is therefore less speculative. Consequently, the quality of the patents should be closer to that of patents applied for in order to secure the actual knowledge base.

We are not convinced by the argument that patents applied for in order to block competitors receive a smaller number of citations, since competitors are completely deterred from the relevant technological field. This might be the case when the technology is completely closed to any outside research activities. Additionally, real blocking patents are not subject of further development. Thus, subsequent research, which would produce further citations, does not occur. However, technologies have become more complex and numerous single components are necessary to construct a

single final product or system. Consequently, patents on a specific type of technology for a single component do not reduce the attractiveness of patenting an alternative technology with similar functionalities, which may be the basis for a competing component. Such simultaneous innovation and patenting activities are very frequent in more complex industries, e.g. information technology (Varian et al. 2004).

Patents are not only used to block competitors in the market. They are also important instruments for collaborations with companies in both the vertical and horizontal market dimensions. Hall and Ziedonis (2001) show that patents allow further differentiation of the value chain by promoting the division of work in the semi-conductor industry between rather small companies developing the blueprints of new technologies and rather large manufacturers owning production capacities and distribution systems. Furthermore, patents play an increasing role for collaboration at the horizontal level, since the increasing complexity of products, e.g. in the information and telecommunication industry, requires the use of a variety of technologies that even large multinationals cannot efficiently invent and develop. Several studies support the positive relationship between participation in R&D co-operation and patenting activities (Peeters, van Pottelsberghe de la Potterie 2006). However, there is no information available about the value of the patent portfolios of companies involved in co-operations, licensing or cross-licensing. In general, companies have to signal that they possess a rather large patent portfolio in order to get access to important co-operations or cross-licensing arrangements. Therefore, similarly to the patent portfolios of companies using patents for blocking reasons this size incentive has negative implications for the average number of citations of a patent. Furthermore, there is a potential information asymmetry between the patent owners and possible co-operation partners and licensees about the quality of the patented technology, which may be exploited by the former.

Different mechanisms work on markets with information asymmetries between the supply and the demand side. On the supply side signalling strategies could be used, i.e. publishing the names of other licensees or even the citations of their patents. For example, various agencies managing patent pools publish the names of the licensees. Regarding the demand side, companies that use patents extensively as assets in the exchange with other actors have to expect that their collaborators or contract partners will analyse in depth the quality of the patents they are interested in. Consequently, low-quality patent applications might be detected and generate a negative reputation for their owners, which might also be perceived by other possible collaboration partners.[3] If companies assume a tendency towards technology markets with very low information

[3] Sine et al. (2003) analyse the role of reputation for the licensing success of universities.

asymmetries, then companies interested in collaborations are expected to produce patents of quality that are not only different to those patents foreseen for the implementation in own products, but even of higher quality, which should be reflected in above average citation rates. However, if collaboration partners do not have the competencies to detect the quality of patent portfolios or if collaboration is rather short term and collaboration partners change often, then we might observe fewer citations of patents from the portfolios of those companies using patents as assets in exchange processes. In our arguments, we highlight the incentive to produce at first a large patent portfolio and treat the still existing information asymmetry or moral hazard problem as given but not decisive. This is in line with new insights of Noel and Schankerman (2006) who find that bargaining power is considerably enhanced by the pure stock of patents, even though the discussion about the importance of patents as bargaining chips is growing. Taking these arguments we derive the first hypothesis:

H1: The average number of citations of patents in a company's portfolio will be

a) high, when the motive of protection is important in the company's patent strategy,

b) low, when the motive of blocking competitors' inventions is important in the company's patent strategy,

c) low, when the motive of exchange and collaboration is important in the company's patent strategy.

One further characteristic of a patent portfolio is the share of oppositions received by patents in the portfolio of a company. Regarding the motives for patenting we have outlined, companies using patents to protect their technological know-how should on the one hand expect that oppositions from competitors will be more likely, because the rather valuable asset will generate a disadvantage to the competitor. On the other hand, if their patents are of high quality and possible opponents are aware of it, then opposition makes no sense. This argument depends on the predictability of the opposition process, i.e. the opponents can predict the outcome of the opposition process ex ante based on the objective quality of the opposed patent.

Compared to companies using patents to protect their own technological knowledge base, companies using patents explicitly as an instrument to block competitors in their competition strategies will receive a more critical feedback from competitors. Since the technological space and future market opportunities of the competitors will be deprived by these kinds of patents, they have a higher incentive to invest in opposing these kinds of applications. Furthermore, the chance of a successful opposition is higher due to the expectation that a blocking company has more low quality patents in its portfolio.

Consequently, we should expect a higher likelihood of opposition for the whole portfolio.

The motivation to use patents as assets in exchange processes, i.e. to generate licensing revenues and incentives to trade, to use them in cross-licensing or for improving the position in co-operations, is based on a fairly collaborative strategy. Consequently, these companies apply for patents that improve their attractiveness as a co-operation or contract partner. Compared to using patents simply for the protection of the company's own technological know-how or even for blocking competitors, this strategy should not generate oppositions from other companies. Similarly, if these companies are important players in various co-operations, their partners are likely to solve possible disputes internally and not via raising oppositions. Based on these considerations, we derive the second hypothesis:

H2: The probability of an opposition against patents in a company's portfolio is

a) high, when the motive of protection is important in the company's patent strategy,

b) high, when the blocking motive is important in the company's patent strategy,

c) low, when the motive of exchange and collaboration is important in the company's patent strategy.

Generally, we argue that a motivation structure of patenting companies which tend to include more strategic elements shifts the characteristics of the portfolio towards a portfolio with a relatively smaller number of citations. The incidence of opposition is also influenced by these motives.

5 Description of Data

Our analysis is based on the combination of survey information on companies' patenting motives with information on their patent portfolio. All German companies that had applied for a minimum of three patents in 1999 – more than 1500 companies in total – were contacted via paper questionnaire in the year 2002 (Blind et al. 2003). The survey achieved a response rate of over 33% and thus over 500 completed questionnaires were received.[4] The companies participating in the survey are

[4] The large majority (more than 85%) of the persons who filled in the questionnaire are involved in the strategic issues of patenting (CEO, patent department) and not in the purely technical aspects

responsible for more than 40% of all German applications at the European Patent Office for the year 1999. The survey covers a considerable share of very large, actively patenting companies. The sample comprises very large and very small companies with an average of 6,374 employees and a median of 517 employees. The companies that had answered the survey were then identified in the patent data of the European Patent Office. This was done via a string search comparing company name and address with the applicant information in the EPO data. The results of the search underwent a thorough manual plausibility check. After removing observations with insufficient company information, we end up with a sample of 457 companies for which we have combined information on motives and EPO patents.[5]

Now to a brief description of the construction of the motive structure we applied as explanatory variables. Originally, the patenting motives are taken from the company survey. Respondents were asked to rate the motives on a five-point scale from 1 for not important to 5 for very important. In order to classify the information about the motives we grouped them into the three categories (protection, blocking, exchanging). As we regarded the protection of innovation and market shares as the original protection motive, we decided through the correlation structure in Table 1 that those original variables should be transformed into one variable, the protection motive. It is calculated as the average assessment of all answers in this group. The offensive blocking motive is defined as preventing competitors from application of technological developments and was taken directly from assessments of the questionnaires. Defensive blocking of competitors is securing leeway to develop one's own technology without using the patents commercially. Again, this variable is taken directly from the questionnaire. The third block of motives – the exchange motives – is used as the average assessment of the motives income from licensing, use for cross-licensing, and cooperation.

Table 1: Correlation Structure of the Motives

Descriptive statistics relating to our dataset can be found in Table 2. We define two dependent variables to describe average characteristics of the patents contained in the

(R&D manager, engineers). This supports the validity of the answers. Only 13% of the responses came from persons representing the R&D department.

5 The data about the companies' patent portfolios can be assumed completely independent from the survey answers, since the respondents do in general have no easy access to the specific characteristics, e. g. the citations, of their patents.

portfolio. Our first characteristic is the average number of citations.[6] Patents receive citations over a very long period of time, which makes older patents on average more heavily cited. To avoid an influence of the age of the patents in the portfolio, we only consider the citations that a patent receives in the first five years after the EPO published the search report for the patent. On average, a patent receives 0.73 citations including self-citations, i.e. citations by other patents of the same company.[7] Using this variable we have to deal with the problem that the distribution is highly skewed and citations are often cumulated in one patent of the portfolio. In order to take this into account the average number of citations per patent is only an appropriate measure for the characteristics of the portfolio when we assume that each citation adds the same contribution to the the whole patent portfolio, irrespective whether few patents receive many citations or many patents of the portfolio receive a small number of citations. The variable citation reveals no substantial skewness. For the problem that the speed of citations may vary we control for the age of the patent at the time we observe the citation. Additionally, we include technology dummies in order to take different citation behaviour in various technologies into account. Like Hall et. al (2002) we also applied the assumption that the flow of citation does vary over the life time of a patent but that general citation behaviour in each technology does not change over time (e.g. for patents applied for later in time) and within technology groups. The phenomenon of opposition is captured by the share of patents that were opposed. This variable indicates that 4 percent of all patents are opposed, which again shows that only a small number of patents are subject of dispute after granting.

Table 2: Descriptive Statistics

The average scores of the motive clusters show rather pronounced differences in the importance of the motive clusters. It ranges from a high of 3.99 for defensive blocking to a low of 2.46 for the average of the exchange motives, whereas the blocking motives taken together reach an average assessment of 3.92. Offensive blocking is slightly less important than defensive blocking (3.85 compared to 3.99). We assume that in cases

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6 We thank Dietmar Harhoff from the Ludwig-Maximilians-Universität in Munich for making the citation data available to us. A detailed description of the citation data can be found in Harhoff et al (2006).

7 There is probably a difference in the impact of the motives of patenting on the number of self-citations compared to non-self citation. We would expect that, independently from the motives, the number of self-citations is preferred to be high to indicate the importance of the patent. However, since the citations at the EPO are mainly assigned by the examiner the citation and self-citations might not be a signal of the applicant's strategy or his patenting motive.

where the average evaluation of a certain motive is higher that there is a higher share of patents which are applied for according to this motive.

In addition, we use dummy variables to classify the companies into four types according to their evaluation of the protection, defensive blocking, offensive blocking and exchange motive. Companies that give the protection motive a higher valuation than the remaining three motives constitute the basis category. The dummy for a defensive blocking company takes the value of one if this motive has the highest score, and is zero otherwise. The dummies for offensive blocking and exchange company are defined analogously.

For the characteristics of the patent portfolios we consider patents that were applied for in the time period 1991-2000.[8] On average the companies hold 114 patents, while the median is 15. This indicates a skewness of the distribution also found in other studies. We include dummies to control for the technology to which the majority of a company's patents belong. 48.9% of companies have a focus on mechanical technologies, 22.2% on electronics, 14.1% on chemicals, 5.5% on pharmaceuticals and 9.3% on other technologies.

Further description of the motive relevance among the patentees is given in Table 3. The upper panel shows how the motive evaluation is distributed over technology classes in which the companies mainly patent.

Table 3 Importance of Motives by Technological Area and Company Size, Means

The variation among the technological fields is not considerable except in the case of chemicals. Here a higher valuation of all patenting motives reflects the higher reliance of this technology on patents. The lower panel of Table 3 displays that companies of different sizes vary in their evaluation of the motives. Especially very small and very large companies assign more importance to the exchange motive than medium-sized companies.

8 The results remain almost identical when we choose the time period 1996-2000. We assume that the characteristics of companies' patent portfolios are quite stable over time, which allows us to explain them with the company characteristics and motive assessments given in the year 2002.

6 Results and Interpretation

In our empirical analysis we investigate how the average number of citations of the patents in a company's portfolio and the incidence of opposition are related to the patenting motives of the company. In separate regressions, presented in Table 4 and Table 5, we shed light on the direct relationship between several patenting motives and the patent portfolio characteristics. We apply a Tobit model in order to take into account that more than 10 percent of the companies do not receive any citations. A similar pattern is observed for the opposition equation where the share of portfolios without any opposition is about 50 percent. The standard errors are estimated robustly in all equations.

Table 4 displays the regression results that are relevant for hypothesis 1, which seeks to explain differences in the average citations of companies' patent portfolios. In columns (1) to (4) we use the average valuation of each motive as the explanatory variable in separate equations. If we use these average relevance assessments of the four clusters of motives (column (5)), we can confirm hypothesis 1a), namely *that the more intensively companies use patents to achieve the protection objective, the higher is the average number of citations their patent portfolio receives* (see also column (1)). However, we could not find significant support for hypotheses 1b) and 1c) using the average relevance assessment approach. The results of these separate regressions are shown in column (2) to (4).[9]

Table 4: Tobit Regressions Explaining Average Number of Citations (Marginal Effects)

In our first hypothesis, we state that companies that use patents to block competitors have patent portfolios with a low number of citations. However, we differentiate further between offensive and defensive blocking strategies: we contend that the latter will lead to higher cited patents while the former will produce patents with less citations. The equation in column (5) integrates all average motive evaluations. Therefore we control for the absolute importance of patenting within the company which changes the results regarding the blocking motives, i.e. additional emphasis on using patents for blocking competitors now has a negative, but insignificant impact on the number of citations of companies' portfolios.

9 We used logs of the average citation variable in order to take the skewness of the patent value indicator into account. However, since the variable is not highly skewed we obtain almost identical results.

An alternative approach is to construct dummy variables for specific types of companies. In column (6) we classify companies as having a general tendency towards protecting, defensive blocking, offensive blocking, or exchanging. This dummy approach reveals conclusively that companies' patents receive fewer citations when it is an offensive blocking company or a company using patents in exchange relations with other companies compared to companies that are more protecting companies ("Dummy for protecting" is the omitted dummy variable). The results of the Tobit regression in column (6) reveal emphatically that the patent portfolios of both companies using patents to block competitors offensively and those using them as bartering chips in the interactions with other companies receive significantly less citations on average for their patent portfolios compared to the companies employing patents to protect their own technological know-how. The latter results provides empirical support for our hypothesis 1c), whereas hypotheses 1b) finds support only regarding offensive blocking.

In all three regression approaches, we find a significant positive influence of the portfolio size on the indicator citations. The positive influence of the portfolio size on citations is a clear indication of economies of scale or even learning curves in the production of patents, which ultimately also leads to patents with a higher number of citations. The explanatory power of the variable portfolio size is strictly dominating those of the motive variables. This is in line with the literature (e.g. Hall et. al. (2005)) on the one hand. However, the variables explaining the motivation of the patent decision in the companies remain still robust and significant in the regressions on the other hand.

Summarising and interpreting the results of the regressions in order to explain the citations of companies' portfolios, we come to the following conclusion. The patent portfolios of companies that generally use patents to protect their technologies have a relatively higher number of citations than those of firms which try to block their competitors by strategic behaviour. This result exactly reflects our hypothesis one. In addition, we find a difference between average citations of portfolios of companies using patents for offensive and defensive purposes. This difference can be explained by the argument that defensive blocking leads to patents which are closely related to the already existing patent portfolio of the companies. Additionally, these patents already take future protection needs into account. Consequently, these patents benefit positively from the actual research activities and are very similar to patents applied to protect the current technological base. In contrast patents used for offensive blocking are of less

technological value, since they are not able to benefit to the same extent from positive synergies with a firm's current research.[10]

Furthermore, the average number of citations of patents in the portfolios of companies using patents for their original purpose is also significantly higher than those in portfolios of companies using patents to generate licensing revenues, as bartering chips in cross-licensing arrangements or in negotiations with other companies in co-operations. This result confirms our hypothesis 1c). As already argued above, portfolio size is an important indicator for those engaged in using patents in licensing and co-operation, which may also lead to patent applications with a lower number of citations.

Regarding the second hypothesis focusing on the likelihood of oppositions, measured by the share of patents in a portfolio that are opposed, we apply the same regression models as presented in Table 4. Again, the relevance assessment of the protection motive has a significant impact on the probability of opposition which may point to a higher incidence of opposition for more important patents but also indicates that protection of technological know-how is a serious competitive strategy, which is likely to be answered by oppositions on the part of competitors (Table 5). Using the average evaluation of the other motives either solely or in the integrated equation does not reveal any significant relationship between the defensive blocking motivation and opposition against the companies' portfolios. The same holds for the exchange motive. However, we find a significant correlation between offensive blocking and the likelihood that a portfolio will face opposition (column (3)). The regression in column (5) considers this phenomenon as well. We can partly confirm hypothesis 2b), since especially aggressive offensive patenting provokes oppositions, whereas defensive blocking is not more likely to encourage oppositions from competitors than just protecting the actual technological base. Simple defensive blocking strategies may only lead to opposition, if the competitors behave rather aggressively, because both the incentives to oppose and the chances of successful opposition are lower than in the case of offensive patents, because the latter do not originate from the core of companies' technological bases. Using the integrated equation with all motives explaining the likelihood of opposition, the effect of the protection motive vanishes and becomes insignificant.

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10 We applied an alternative way of defining dummy variables. The variable HIGH was set to 1 if the motive has a value larger than four. We obtain almost identical results with this approach. The results seem to be robust in respect to this change in the specification.

Table 5: Tobit Regressions Explaining Share of Oppositions (Marginal Effects)

In the model in column (6), we use the dummy approach in order to find out whether companies following a certain patent strategy have a higher likelihood of opposition in their patent portfolios. We find no significantly higher share of opposition among companies using patents for defensively blocking competitors compared to companies using patents in their originally intended sense. However, we can confirm that offensive blocking has a positive, but weakly significant effect. In the model specification of column 6 we find strong support for our hypothesis 2c) that companies which favour the exchange strategy face less opposition than companies that use patents mainly to protect their inventions.

Companies employing patents as bartering chips in licensing arrangements or co-operations have a similar share of oppositions as those using patents for protection purposes. In the dummy model (column 6), we find even that this type of company has significantly lower shares of opposition.

We conclude that the incidence of opposition is highly correlated with the number of citations of the patented innovation but that the interpretation of this strategic instrument is complex. For this reason we included the citation measure as a control variable. The coefficients of the motives then capture the impact on the strategic use of opposition as an indicator of dispute. In all six regression models both the citations and the portfolio size have a significant positive influence on the share of opposition. Larger players also face a positive scale effect in receiving opposition.[11]

Interpreting the regression results to explain the share of opposition, we come to the following conclusions. Offensive blocking strategies provoke significantly more opposition, whereas the impact of defensive blocking is no different than that of just using patents to protect the current technological portfolio. The rather weak support for our hypothesis, that blocking strategies have a positive influence on the share of oppositions, can be explained by a further link we have proved in the regressions related to the citations. Here we argue and find the empirical evidence that the traditional use of patents to protect the technological base leads to patents with a rather high number of citations compared to the patents generated under a blocking strategy. The regressions explaining the shares of oppositions show a very strong explanatory power of the number of citations. Consequently, those companies utilising patents to protect their own technological know-how receive not only a higher number of citations, but also of

11 See also Harhoff and Reitzig (2004).

oppositions. This effect reduces the difference to the pure opposition-provoking effect of companies that employ patents in their blocking strategies. This explains the rather low explanatory power of these variables, i.e. only offensive blocking is positively significantly correlated with the share of oppositions.

The companies using patents for exchange motives receive a smaller number of oppositions than those just using them for protecting objectives. Obviously, this company type intends to follow a protection strategy causing relatively little conflicts, since the negative reputation effect is much more severe and long-lasting in the whole market in which the company is active, compared to the gains of pursuing one specific patent claim against a possible competitor or collaboration partner.

7 Conclusions

This paper analyses for the first time how strategic motives of patenting are related to the characteristics of companies' patent portfolios. Using a data set of more than 450 companies we find – based on different regression approaches – that strategic patenting has an influence on the companies' patent portfolios.

First, companies that use patents to protect their technological base and their markets receive a higher number of citations compared to those that use patents to block competitors or as bartering chips in collaborations with licensing relations. This finding confirms our first hypothesis. However, it should be noted that there is a difference between the patent portfolios of companies using patents for defensive blocking, i.e. securing their own future technological space, and applying patents to offensively block competitors. The latter receive significantly less citations.

Second, companies using patents to offensively block competitors receive – as postulated in our second hypothesis – a higher share of oppositions to their portfolios. There is no significant relationship between the defensive use of patents and the opposition indicator. A further hypothesis is also confirmed since companies using patents in exchange relations with licensees or licensors face a smaller share of opposition than those companies using patents merely for protection purposes.

These new insights make important contributions to the discussion on strategic patenting. Since we find considerable closeness between the traditional protection motive and the defensive blocking strategy, but significant differences between the latter and offensive blocking, we have to interpret defensive blocking as a kind of forward-oriented traditional protection strategy, which can therefore be subsumed into the traditional motive. Very different is offensive blocking of competitors by means of

patents, which is clearly a case of the patent system being used for purposes other than for which it was originally intended. Although using patents as bartering chips in collaborations does not lead to patents of higher, but of lower quality, this motive has the positive side-effect of avoiding conflicts in the opposition phase and looking for more informal and therefore more efficient conflict solution mechanisms. In summary, offensive blocking is the most critical and costly strategic patent motive from the perspective of the patenting authorities.

Based on these findings we can derive the following policy implications. First, companies using patents as bartering chips possess patent portfolios with similar characteristics. It must also be noted that this type of company generally tries to follow a patenting strategy which does not cause severe conflicts with possible collaboration partners. This additional pressure to secure its reputation is a positive force for conflict resolution. Second, the phenomenon of frequent oppositions and rather limited citations in a company's patent portfolio is an indication that the company is following an offensive blocking strategy and thus misusing the patent system. This is a potential information source, which could be used in investigations of anti-competitive behaviour in specific markets or by single companies. In summary, this analysis has confirmed the validity and the usability of patent portfolio characteristics not only for innovation management, but also policy issues.

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Table 1: Correlation Structure of the Motives

	Imit. prot.	M. share, national	M. share, Europe	M. share, excl. Eur.	Off. Block.	Def. block.	Lic. income	Cross-licensing	Coop.
Imitation protection	1.00								
Market share, national	0.39*	1.00							
Market share, Europe	0.35*	0.65*	1.00						
Market share, excl. Europe	0.21*	0.33*	0.69*	1.00					
Offensive blocking	0.38*	0.26*	0.28*	0.26*	1.00				
Defensive blocking	0.23*	0.21*	0.25*	0.28*	0.24*	1.00			
Income from licencing	0.04	0.12*	0.17*	0.23*	0.06	0.04	1.00		
Use for cross-licencing	-0.02	0.01	0.08	0.18*	0.02	0.17*	0.47*	1.00	
Cooperation	0.04	0.18*	0.20*	0.22*	0.06	0.20*	0.51*	0.50*	1.00

Note: * indicates significance at the 5%-level.

Table 2: Descriptive Statistics

	Mean	Median	s.d.	skewness	Min	Max
Dependent Variables						
Citations	0.73	0.65	0.56	1.44	0	4
Share opposition	0.04	0.00	0.08		0	1
Motives						
Imitation protection	3.95	4	0.82	-0.75	1	5
Defensive blocking	3.99	4	0.96	-0.76	1	5
Offensive blocking	3.86	4	1.05	-0.71	1	5
Exchange	2.46	2.33	1.07	0.29	1	5
Company Classification						
Dummy defensive blocking company	0.40	0	0.49		0	1
Dummy offensive blocking company	0.18	0	0.38		0	1
Dummy exchange company	0.03	0	0.16		0	1
Control Variables						
Portfolio size (patent applications with priority '91-'00)	114	15	629	11.45	1	9,534

Table 3: Importance of Motives by Technological Area and Company Size, Means

	Protection Motive	Blocking Motive	Exchange Motive	Number of Observation
Technological Area				
Pharmaceuticals	3.94	3.90	2.52	29
Chemicals	4.23	4.15	3.18	66
Electronics	3.85	3.77	2.59	102
Mechanical	3.93	3.95	2.23	224
Other	3.85	3.81	2.22	36
Number of Employees				
1 – 100	4.00	3.90	2.71	95
101 – 1000	3.95	3.96	2.17	193
1001 – 5000	3.88	3.83	2.44	104
> 5000	3.96	3.99	3.02	65
Total	3.95	3.92	2.46	457

Table 4: Tobit Regressions Explaining Average Number of Citations (Marginal Effects)

Dependent Variable	Citations					
	(1)	(2)	(3)	(4)	(5)	(6)
Imitation protection	0.074**				0.081***	
	(0.029)				(0.029)	
Defensive blocking		0.009			-0.011	
		(0.026)			(0.026)	
Offensive blocking			0.006		-0.015	
			(0.023)		(0.022)	
Exchange				0.030	0.023	
				(0.026)	(0.026)	
Dummy defensive blocking company						-0.071
						(0.055)
Dummy offensive blocking company						-0.104*
						(0.062)
Dummy exchange company						-0.321**
						(0.140)
Portfolio size	0.126***	0.130***	0.131***	0.125***	0.123***	0.133***
	(0.016)	(0.016)	(0.016)	(0.017)	(0.017)	(0.016)
Dummy technology drugs/health	0.362**	0.363**	0.361**	0.354**	0.355**	0.372**
	(0.158)	(0.157)	(0.156)	(0.159)	(0.161)	(0.158)
Dummy technology chemicals	0.086	0.102	0.104	0.080	0.070	0.105
	(0.075)	(0.077)	(0.077)	(0.076)	(0.074)	(0.078)
Dummy technology electronics	-0.081	-0.089	-0.860	-0.097	-0.093	-0.081
	(0.061)	(0.061)	(0.062)	(0.060)	(0.060)	(0.061)
Dummy technology other	-0.076	-0.080	-0.804	-0.082	-0.079	-0.083
	(0.064)	(0.063)	(0.063)	(0.062)	(0.064)	(0.063)
No of observations	457	457	457	457	457	457
Log pseudo-likelihood	-389	-392	-392	-392	-388	-388

Note: Marginal effects and their robust standard errors are reported. *, **, *** indicate significance at the 10%, 5%, 1% significance level. The regressions contain dummies for four categories of company age. The reference category of the technology dummies is ‘mechanical’. The reference category for the motive dummies is ‘dummy imitation protection company’.

Table 5: Tobit Regressions Explaining Share of Oppositions (Marginal Effects)

Dependent Variable	Share of Opposition					
	(1)	(2)	(3)	(4)	(5)	(6)
Imitation protection	0.007*				0.004	
	(0.004)				(0.004)	
Defensive blocking		0.001			-0.002	
		(0.004)			(0.004)	
Offensive blocking			0.007**		0.006*	
			(0.003)		(0.003)	
Exchange				0.002	0.002	
				(0.003)	(0.003)	
Dummy defensive blocking company						-0.004
						(0.006)
Dummy offensive blocking company						0.001
						(0.008)
Dummy exchange company						-0.020***
						(0.007)
Citations	0.019***	0.020***	0.020***	0.020***	0.019***	0.019***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
Portfolio size	0.008***	0.008***	0.008***	0.008***	0.007***	0.008***
	(0.002)	(0.002)	(0.016)	(0.002)	(0.002)	(0.002)
Dummy technology drugs/health	-0.019**	-	-	-	-	-0.019***
	(0.007)	0.020***	0.019***	0.020***	0.019***	(0.007)
		(0.007)	(0.007)	(0.001)	(0.007)	
Dummy technology chemicals	0.002	0.003	0.002	0.002	0.001	0.003
	(0.011)	(0.111)	(0.010)	(0.011)	(0.011)	(0.011)
Dummy technology electronics	-0.012*	-0.013**	-0.001	-0.014**	-0.011	-0.012*
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)
Dummy technology other	-0.001	-0.001	-0.001	-0.002	-0.001	-0.002
	(0.011)	(0.012)	(0.012)	(0.012)	(0.010)	(0.011)
No of observations	457	457	457	457	457	457
Log pseudo-likelihood	-11.4	-13.0	-10.1	-12.9	-9.4	-12.1

Note: Marginal effects and their robust standard errors are reported. *, **, *** indicate significance at the 10%, 5%, 1% significance level. The regressions contain dummies for four categories of company age. The reference category of the technology dummies is ‘mechanical’. The reference category for the motive dummies is ‘dummy imitation protection company’.