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Is Strategic Patenting still in vogue? A Reassessment of Motives to Patent a Decade after the Patent Peak

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Abstract

Motivation

During the patent surge in the late 1990s and its peak in the early 2000s, a lot of investigations regarding the motivation of companies to patent were conducted. Studies have found that the traditional patenting reason of protecting inventions from imitation is most important to companies, but strategic motives to patent have experienced a higher relevance during the patent rise (e.g. Arundel, van de Paal, Soete, 1995; Blind, Edler, Frietsch, Schmoch, 2006). However, a reexamination of patenting motives has not been performed since the number of patent applications started stagnating.

Research Gap

The present paper addresses two research questions: first, we test if the relevance of patenting as an instrument to protect knowledge as well as the importance of various reasons to use patents has changed over the last decade. Second, we analyze if the breadth of patent motives has changed and by which company specific factors the scope of

the patent motives is influenced. Therefore, the main contribution of our research to the field of innovation economics lies in the comparison of two samples of the same basic population at different points in time, which allows us to observe changes in the motivation of companies to apply for patents.

Sample and Methods

Our study relies on a dataset of 539 German companies which was collected in 2011. We compare our results with the findings of the paper Motives to patent: Empirical Evidence from Germany (Blind et al., 2006) based on a dataset collected in 2002. Both datasets use the same items of patenting motives and the sectors as well as size structure of both samples are quite similar. Nevertheless, in order to meet concerns about potential biases between both samples, we use a propensity score matching from which we derive two balanced samples. Afterwards, we test for changes in the assessment of various protection instruments and motives to patent by running a two-sample t-test. Furthermore, we use an explanatory factor analysis to identify superordinated factors of reasons to patent. Finally, we run an ordered logistic regression to analyze the impact of company specific characteristics on the scope of companies patent motives. This analysis is based on the outcomes of the explanatory factor analysis. We use the factors to generate an ordinal index by which we measure the breadth of the patent motives.

Results

The differences regarding the assessment of various protection instruments between the two samples show that patenting is still the most important formal instrument to protect a companys intellectual property. However, the relevance of instruments like secrecy or utility patents has increased significantly. Regarding the importance of the patent motives, traditional motives like strengthening the market position and the protection against imitation still remain the main reasons for filing a patent. More strategic motives like employee motivation, access to capital markets or the improvement of the corporate image have lost in relevance. Therefore, the scope of patent motives has decreased with a higher focus on the traditional motives. The results of our factor analysis support this argument. In comparison to Blind et al. (2006) who revealed five superordinated patent motives (protection, blockade, reputation, exchange and incentive), the factor analysis based on the answers of the recent sample generated three factors: protection & blocking, reputation & incentive as well as exchange. We observe that the blocking motives merge with the protection motives and the incentive motives fuse with the reputation motives. Only the exchange motives remain a single factor as in Blind et al. (2006). Thus, companies seem to ponder the implications of blocking competitors while applying for a patent due to protection reasons. Also, internal (e.g. incentive for employees) and external (e.g. improving technological image) motives to patent are nowadays highly correlated in companies considerations regarding IP strategies. These results point to a more integrated approach in companies patenting strategies compared to 2002 and indicate that organizational learning (Huber, 1991; March, 1991) has occurred over the last decade. Regarding the factors which may influence the breadth of patent motives, we find that the research and development intensity, the filing of trademarks, the usage of secrecy and the search in patent databases have a positive impact on the breadth of patent motives.

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Is Strategic Patenting still in vogue and what drives the diversity of a company's patent strategy?

A Reassessment of Motives to Patent a Decade after the Patent Surge

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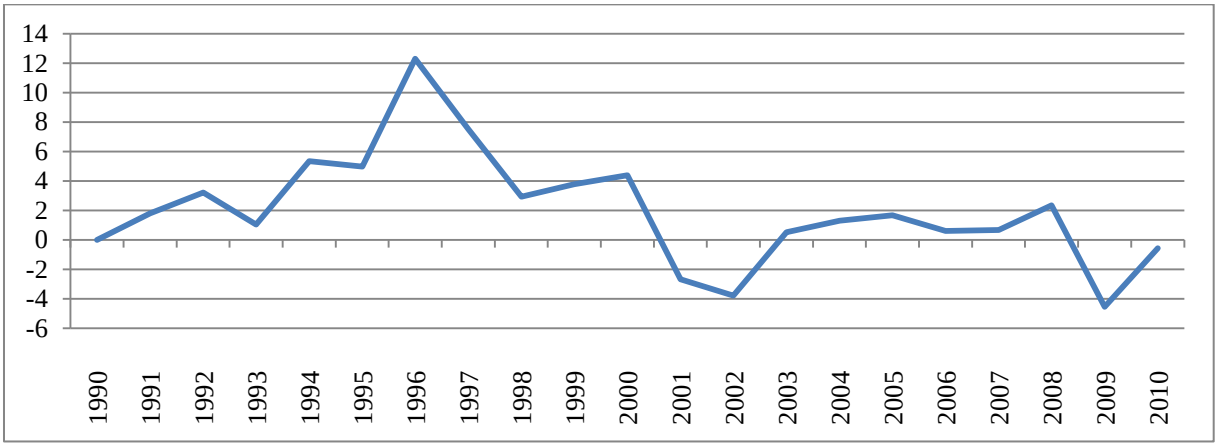
ABSTRACT

This study examines changes in the importance of different reasons to apply for a patent over the last decade as well as driving factors for the diversity of a company's patent strategy. Our results suggest that, first, patents are still the most important formal instrument to protect a company's intellectual property, second, traditional and market-related patent motives remain most important while more strategic motives have lost in significance, third, companies use a more integrated patent strategy and, finally, the diversity of a company's set of patenting motives is not influenced by firm size but rather by its research and development intensity, the frequency of information search in patents and the importance of other protection instruments.

1. INTRODUCTION

There has been an unprecedented surge in the number of patent applications during the late 1990s which, however, was not accompanied by a rise in the R&D expenditures of companies (see Blind & Thumm, 2004). As a result, this aspect gave many researchers the idea to examine the issue of driving motives for patent applications (see e.g. Arundel, van de Paal G., & Soete L., 1995; Duguet & Kabla, 1998; Cohen, Goto, Nagata, Nelson, & Walsh, 2002 or Pitkethly, 2001). In the case of Germany, Blind, Edler, Frietsch, & Schmoch (2006) copes with this phenomenon by investigating data collected in 2002 on several reasons to apply for patents. Mainly, they find strategic motives (e.g. exchanging patents or blocking competitors) to have become more important since the beginning of the 1990s. Nowadays, however, the number of applications filed at the DPMA is stagnating (see figure 1). It becomes obvious that the annual growth rates within the five years before 2002 has been much higher than before 2011. More precisely, the average annual growth rate of patent applications at the German patent office between 1996 and 2000 has been about six per cent whereas it has been only slightly more than zero growth between 2005 and 2009[1]. Phenomena like the increasing number of patent litigations, patent trolls (Fischer & Henkel, 2012) as well as patent thickets (Graevenitz, Wagner, & Harhoff, 2011) might be the reasons for these significant changes in the patent landscape which might be accompanied by changes in the motives to patent.

Fig. 1
Annual growth rate in the number of patent applications at the DMPA (1990-2010)[2]



Even though actual studies like Somaya (2012) show the continuous relevance of patent motives in management research, there have been no studies which analyse the changes of the patent motives in a longitudinal analysis. Furthermore, it still remains unclear why some companies pursue a diversified spectrum of patent motives while others are highly focused.

[1] Notice: Due to the fact that patent applications are published by the patent office not until 18 months after the date of application, we skip the years before the
[2] Source: Own calculation based on data from http://ipstatsdb.wipo.org/ipstats/ipstats/patentsSearch.

The analysis of these topics is highly relevant for two reasons. First, a longitudinal analysis of the patent motives allows us to comprehend how the strategic patent behaviour of companies has changed over the last decade and if we can observe organizational learning, in the sense of making patenting more efficient and adapting it to strategies of other actors in the market. Furthermore, it is highly relevant to understand changes in the patent landscape in order to react to those changes by adapting relevant structures on a policy level. Second, the evaluation of the interplay of patent motives has a high relevance for companies' management. Since patent management is a cost intensive process, it is very relevant for companies to understand which patent strategies are interrelated and which resources and competences are needed to implement a patent strategy. Therefore, this paper tries to fill this gap by comparing data on motives to patent from 2002 with actual data collected in 2011 and, hence, to identify changes in companies' patenting behaviour.

As outlined above, the situation regarding the number of patent applications before the surveys conducted in 2002 respectively 2011 differ: Whereas there has been a rise in the number of applications before the first survey conducted in 2002, there has been stagnation in patenting before 2011. Thus, we have to regard the results in the upcoming part of the paper in the light of two different environments regarding the patenting landscape. This might be due to the fact that the patent landscape gets more and more competitive (Granstrand, 2000) and the room to manoeuvre shrinks. Accordingly, some authors argue that the overgrowth in patents may cause an underuse of the underlying resources – the so called "tragedy of anticommons" (Heller, 1998) which, again, might lead to a decreasing utility of patents. Consequently, the observed stalemate in the growth rate of patent applications might follow. Therefore, we wonder if this phenomenon might also implicate changes in companies' patenting behaviour as the observed decreasing growth rate of patent applications might be accompanied by shrinking relevance of some reasons to patent. Furthermore, changes in companies' assessment of the different motives to patent might also alter the interplay between the motives within companies' patenting strategy as well as the diversity of companies' patenting motives. Consequently, this paper identifies not only changes in the relevance of motives to patent over time but also in the relation between these motives as well as the breadth of reasons of companies to apply for patents.

The remainder of the paper is structured as follows. First, we give a summary on the up to now conducted research on patents as an appropriation method of returns to innovation efforts as well as on the research on motives to patent. By analysing the results of the most important

empirical studies, we develop hypotheses for the empirical part of the paper. Second, the introduction of the data used for empirical analyses follows. Third, we analyse the relevance of instruments to protect intellectual property (with special emphasis on patenting) as well as motives to patent. Furthermore, we want to identify changes in the assessment over time. Therefore, we compare our findings to the results presented by Blind et al. (2006). Subsequently, we conduct a factor analysis in order to reduce the wide array of motive variables. The extracted factors help to construct the dependent variable of a multivariate ordered probit model which explains the breadth diversity of motives to apply for a patent of a company. Finally, we discuss the results as well as the limitation and future research.

2. THERORETICAL FRAMEWORK

Literature Review

This part of our paper reviews the existing literature on patents and the motives to patent as well as to explain patenting in the framework of the resourced based view in order to develop some hypotheses for the upcoming empirical part. Firstly and principally, patents can be seen as technical resources (Grant, 1991). Due to several facts, they can be seen as capable resources to achieve a sustainable competitive advantage: they confer relevant technological knowledge, their imitation is illegal, the option of inventing around them oftentimes implies exorbitant amounts of resources (e.g. time and capital) and the substitutability is mostly imperfect (Markman, 2004; Teece, 1986; Hall, 1993; Teece, Pisano, & Shuen, 1997). Especially in dynamic and highly competitive markets, patents are a crucial resource for the success of a company (Arora, Fosfuri, & Gambardella, op. 2001). Changes in the technical environment characterized by more and more complex and cumulative landscapes as well as systemic technologies make the successful development and commercialization of new technologies and products hardly possible if complementary technologies and patents are not pooled together (Teece, 2006). As a result, patents have become a critical managerial aspect to leverage a firm's technological resources (Pisano, 2006) and patent active companies are more innovative and successful in their particular industry (Ernst, 1995).

While patents can be seen as technological resources with the potential to achieve a competitive advantage, companies have to develop specific competences to leverage the value of their technical resources. In this connection competences characterize a complex bundle of capabilities which allows the firm to use its resources more effectively and efficiently (Prahalad & Hamel, 1990). A company has to develop such complex managerial competences to development a valuable patent strategy (Pitkethly, 2001). As a consequence companies spend extensive resources on the development of their patent portfolios (Argyres & Silverman, 2004) and a variety of patent motives have emerged over time (Somaya, 2012; Blind et al., 2006).

In general we can differentiate between traditional market-related and strategic motives to patent (Blind et al., 2006).[3] The traditional market-related motive describes the use of patents in their original function as a protection instrument. Their capability to *"stake out and defend a proprietary market advantage"* can be regarded as most important within that context

[3] The categorization/classification of patent strategies varies between different studies. We use the classification from Blind, Edler, Frietsch, & Schmoch (2006).

(Rivette & Kline, 2000). As a result companies are able to protect their unique set of resources from imitation which gives them the opportunity to achieve "first mover advantages" (Lieberman & Montgomery, 1988; Markman, 2004) that imply the freedom to operate, the establishment of distribution channels, customer loyalty, and reputation (Barney, 1991; Mazzoleni & Nelson, 1998). Besides the traditional market-related motives, a multitude of strategic patent motives has derived which are uncoupled from the original protection motive (Blind et al., 2006). Strategic motives can be defined as *"(...) the decision to* patent - *despite the significance of the protection motive (...)"* (Blind, Cremers, & Mueller, 2009: 656). Most prominent are the motives to use patents as blocking instruments, bargaining chips as well as incentive and reputation instruments (Cohen, Nelson, & Walsh, 2000; Blind et al., 2006; Cohen et al., 2002; Lerner, 1995).

As a blocking instrument, patents are used to create market entry barriers (Grant, 1991), for instance, by building patent thickets or patent fences (Granstrand, 2000). We can differentiate between two general blocking strategies: offensive and defensive. Offensive blocking characterizes a strategy where patents are used to attack, alienate and reduce the room of action from actual and potential competitors (Blind et al., 2006). For this purpose, a patent does not even have to be granted as the application process can be strategically shaped to increase the pendency time and therefore reduce the room for potential competitors to manoeuvre (Berger, Blind, & Thumm, 2012). Defensive blocking describes a strategy "*(...)* when firms patent in order to prevent their own technological room to manoeuvre being reduced by the patents of others" (Blind et al., 2006: 657). Especially in rapidly evolving industries, companies open up new technological fields which contain some risks: Opportunities are often combined with high irreversible investments and insufficient knowledge about the patent structure of their competitors. Particularly under such conditions, the exposure to other company´s patents can be eminently problematic (Somaya, 2012) and a systemic technological landscape increases that problem (Hall & Ziedonis, 2001). As a solution companies tend to build patent walls around their products and technologies -called clustering- which can help to ensure freedom of action within that staked out space (Rivette & Kline, 2000). A defensive patent strategy can therefore help to lower hold-up problems, get access to external technologies (Hall & Ziedonis, 2001) and create room to manoeuvre (Guellec, Martinez, & Zuniga, 2008). Such defensive strategies are also pursued through patent pools, cross licencing and standard-setting (Jaffe, 2001) The most prominent example which shows the effectiveness of a defensive patent strategy is the case of Polaroid and Eastman Kodak. Kodak ignored the technical space protected by its smaller rival Polaroid. As

a result, Kodak was guilty of infringing Polaroid´s patents. The compensation which Kodak had to pay was about $925 million. Furthermore, Kodak had to close manufacturing plants and bought back the products sold based on the infringed technology (Rivette & Kline, 2000).

Another strategic motive is the purpose of patents as an exchange instrument. Especially in sectors with fast growing cumulative technologies patens are highly relevant as to avoid hold-up problems and to pave the way to get better access to external technologies (Hall & Ziedonis, 2001; Markman, 2004). In their function as bargaining chips patents are used as a pressurizing medium within strategic alliances and cooperations (Blind et al., 2009; Peeters & de La Pottelsberghe Potterie, 2006; Reitzig, 2004; Lerner, 1995). Related to their reactive function within strategic alliances and cooperations, Noel & Schankerman (2006) show that the patent position of a company is crucial in the case of patent infringements. Companies with a strong patent portfolio are in a better position to solve such disputes. Moreover, the potential of patents to generate licencing revenues has become highly relevant in some company´s patenting strategy. Examples like IBM which has generated more than $10 billion revenue over the last decade (Parchomovsky & Wagner, 2005) or Texas Instruments whose royalty income has increased from $200 million (1987) to $600 million (1995) (Arora et al., op. 2001) prove the potential of licencing revenues which can be generated by patents.

Closely related to their exchange function is the usage of patents as an indicator for the underlying technological resources and capabilities of a company to create new knowledge (Ernst, 2001; Stephan, 2003; Bogner & Bansal, 2007; Ernst, 1995; Peeters & de La Pottelsberghe Potterie, 2006). Patents can be seen as a signalling instrument to increase the visibility of companies which displays their performance and helps to attract potential partners for cross-licencing, R&D-cooperations, standardization and strategic alliances (Arundel, 2001; Long, 2002; Arora et al., op. 2001). Furthermore, they communicate the earnings potential of a company to the financial community and potential investors (Rivette & Kline, 2000). This can especially help small companies to reduce the cost for acquiring external capital and therefore generate supplementary cash flows (Rassenfosse, 2012). The signalling function of patents works also within a company. As scientific and technological output is hard to measure and a granted patent implies that the patented invention is “new”, hence not state of the art, contains an inventive step and is characterized by an industrial application. Thus, patents can be seen as a useful internal incentive/performance instrument for R&D employees (Arai, 1999; Blind et al., 2006; Neuhäusler, 2012).

Regarding the relevance of different patent motives, Blind et al. (2006) compares up to 2003 conducted research results of several well-known surveys regarding motives to patent (Arundel et al., 1995, Duguet & Kabla, 1998, Cohen et al., 2002, Pitkethly, 2001, Schalk, Täger, & Brander, 1999 and OECD, 2003). Except for the OECD study, all investigations find the traditional motive to apply for a patent to be the most important one followed by the strategic blocking motive. The detailed comparison of these empirical studies can be read in Blind et al. (2006), while we concentrate on recent studies published after 2006 in more detail. Veer & Jell (2012) investigates if there are different motivations to apply for a patent for inventors, small companies, large companies and universities. Overall, they find the traditional motive to be most important, closely followed by the offensive blocking motive and securing freedom to operate. Two other motives (signalling and licensing) seem to be considerably less important as reasons to apply for a patent. Sichelman T. and Graham (2011) primarily focussing on start-ups, find that patenting for protection reasons is most important to the survey participants. Rassenfosse (2012) comes to the same results. He finds that SME´s as well as large companies mainly file patents to prevent others from copying their inventions. However, maintaining the freedom to operate is significantly more important to large companies than to SME´s. Strategic motives like the usage of patents to attract potential investors and the usage of patents in the view of licencing are regarded as less important with the additional aspect that SME´s regard both motives as significantly more important than large companies (Rassenfosse, 2012).

Hypotheses

The theoretical framework revealed that strategic patenting has become an important aspect of management strategy since the end of the last century. Companies spend extensive resources on the development of their patent portfolios (Argyres & Silverman, 2004) and have developed enormous competencies to leverage their technological resources. Accordingly, as mentioned before, phenomena like patent trolls, patent litigations, patent fences and thickets have increased and the patent landscape has become a battlefield. Consequently, the patent landscape gets more and more fragmented and overlapping property rights constrains the manoeuvring within it. Heller (1998) describes these phenomena as the "tragedy of the anticommons" where scare resources like patens are underused. Following this thought, patenting becomes more and more expensive because companies have to invest enormous amounts of resources and develop distinguished capabilities to leverage their intellectual property within such a landscape. Today, the prosecution and maintenance cost for a global

patent adds up to $ 100,000. Additionally, transaction costs, the detection of infringements leading to potential trials as well as organizational aspects cause significant costs (Somaya, 2012). Thus, the cost benefit ratio of patents has decreased. Consequently, companies might focus on patenting inventions which bring the highest reward at the market, have a core function for their business and hence need to be protected. Patent applications which base on more strategic reasons (e.g. signalling inventiveness to possible investors) might be put aside due to limited resources and decreasing utility. Therefore, we conclude the following hypothesis:

Hypothesis 1: Strategic patenting motives have become less important due to the decreasing utility of solely strategic patents.

According to the logic of the "tragedy of the anticommons", companies have to use more integrated patent strategies. This means that different reasons to apply for a patent fuse more and more together in the decision making process in order to fulfil more functions with one patent applying for less patents in total. Blind et al. (2006) identifies five different patent motive-clusters: protection, blockade, reputation, exchange and incentive. Under the condition of decreasing rents from patenting, companies have to rethink their patent strategies. Somaya (2012) states, that: (…) "effective patent strategy requires the prioritization of patent-related activities toward specific sets of technologies, and the allocation of resources to acquire, reinforce, and employ the required patent rights." As a result, we propose that companies combine different strategies and therefore use a more integrated patenting approach which is displayed in more correlations between diverse motives to patent.

Hypothesis 2: Companies tend to implement a more integrated patent strategy.

Having discussed changes in the importance of different patenting motives as well as changes in the extent of interaction between them, we are now interested in the factors influencing the diversity of a company's patent strategy. Regarding factors which may drive patent motives, Arundel (2001) finds the propensity to patent an innovation to be relatively low and increasing with firm size but being independent to the R&D intensity of firms. Blind et al. (2006) finds that the company size affects the probability to patent an invention and large companies evaluate patenting as a protection instrument significantly more important than small and medium-sized companies (SMEs) do. In contradiction Peeters and de La Pottelsberghe Potterie (2006) argues that a company's patent strategy is better predicted by its innovation strategy than classical Schumpeterian factors like firm size and market

power. We argue that a broad patent strategy has to be supported by a strong resource base. Without financial, human and organizational resources, it should be hard for a company to manage the complex requirements of a broad patent strategy. Therefore, we postulate:

Hypothesis 3: The size of a company increases the diversity of its set of patent motives.

From a resource perspective, a patent strategy has to maximize the value of the underlying resources covered by that strategy. Considering different kinds of resources (financial, human etc.), especially knowledge intensive resources as an output of the R&D-activities deserve a high protection. Griliches (1990) shows, that R&D intensity and the number of patents are positively correlated. This finding is supported by Blind and Jungmittag (2008) who find that patenting has a higher relevance in industries with a high R&D-intensity. Moreover, he finds that changes in the R&D expenditures lead to changes in the patenting behaviour. Blind et al. (2006) show that especially the exchange and incentive motives are driven by the R&D-intensity. Nevertheless, we argue that also the blocking and protection motives are highly relevant for companies with a high R&D intensity because companies need to protect their intangible assets and use patenting as a blocking instrument to protect their own technological room to manoeuvre. Coming from a resource-based perspective, we therefore argue that a broad set of patent strategies might lead to a more effective and efficient use of the technical, human and financial resources which are comprised in patents. Therefore, companies with a high R&D-intensity have to develop the core competence to use a broad patent strategy to recover sunk costs which are connected with their R&D-intensity or as Rivette & Kline (2000) puts it: "(..) a patent becomes a sunk cost. One can either leverage that sunk cost as a source of R&D funding or bottom line revenue, or one can simply ignore it". Thus, we derive our fourth hypothesis:

Hypothesis 4: Its *R&D intensity increases the diversity of a company's* set of patenting motives.

Our fifth hypothesis focuses on the mix of different protection instruments. Especially in fast changing industries companies use different protection instruments to recoup the investments from their R&D activities (Hall & Ziedonis, 2001). The usage of complementary assets is often necessary to appropriate and protect the rents which are generated by the patent. Teece (1986) points out, that trademarks can become an essential asset to maintain the unique selling point for the customer if a patent expires. Thus, trademarks can be seen as a complementary

instrument which supports the perception of an underlying technology covered by a patent. As a result the acuteness to protect such a product from counterfeiting increases and the protection of the underlying technology through patents becomes more important. Also, companies are in a better position for licensing and exchange. Especially, trademarks are very important for the reputation of a company. Consequently, companies which use trademarks for the purpose of reputation may also use patent strategies for reputation. According to these findings, we derive our fifth hypothesis:

Hypothesis 5: *The relevance of trademarks increases the diversity of a company's* set of patenting motives.

Our last hypothesis refers to the acquisition of information by companies. Patents are a valuable instrument because they allow the monitoring of the technological activities, strengths and weaknesses of a company's competitors (Ernst, 1998). Changes in the technological landscape, like the increasing complexity of technologies, complicate the successful development and commercialization of new products. Therefore, companies are often under compulsion to pool complementary technologies (Teece, 2006) which increases the importance of patents as bargaining chips to avoid hold-up problems (Hall & Ziedonis, 2001). Under these circumstances it becomes increasingly important for companies to monitor their technological environment. The enhanced performance of patent databases allows such monitoring of patents even on a large scale (Ernst, 1998). Since blocking, licensing, exchange and also reputational motives imply an extensive knowledge of the patent landscape, we derive our last hypothesis:

Hypothesis 6: *The search intensity increases the diversity of a company's* set of patenting motives.

3. DATA AND METHODOLOGY

Sample description

The main aim of our research approach is to identify changes in the assessment of various motives to patent over time. For this task, we can rely on data of two different surveys which were conducted among patenting German companies in 2002 respectively in 2011. The dataset of 2002, used as a basis for the analysis in Blind et al. (2006), consists of responses of 532 of more than 1500 contacted companies which applied for at least three patents at the European Patent Office in 1999. This equals a response rate of 33 per cent. The 532 companies within the dataset are responsible for more than 40% of all German applications at the European Patent Office or PCT procedures for the year 1999 (Blind et al., 2006)[4]. The data from 2011 was collected in the framework of a study funded by the Federal Ministry of Economics and Technology. Therefore, all active patenting German companies[5] (6519) were contacted and asked to complete the questionnaire. Thus, a sample of 587 patenting companies was achieved, which equals a response rate of approximately 9 per cent. Furthermore, we have to exclude all observations with missing data on variables that we use in our analyses which leaves us with 519 companies. Despite the low response rate, our sample covers about 24% of all patent applications of German companies at the DPMA, EPO and WIPO (PCT approach) between 2003 and 2009.

Tables 1 and 2 display the size and sector distributions of both samples. The arrangement of the sectors follows (Blind et al., 2006) with some small differences[6]. We analyse seven industrial branches, grouped according to NACE codes: chemistry (20) (including biotechnology (no extra NACE code) as well as rubber and plastics (22)), mechanical engineering (28), motor vehicles (29), construction (41-43), electrical engineering (26 and 27) and metal production (24).

It becomes obvious that the distribution of firms over the seven sectors differs between both samples. Moreover, there are some remarkable differences in the size structure. While the sample from 2002 has *"a bias to higher responses from large companies"* (see Blind et al., 2006: 660), the recent sample bears a higher number of small-and medium sized companies and therefore represents the German manufacturing landscape more adequately.

[4] For further details regarding the dataset please see (Blind et al. (2006)).
[5] As "active" companies, we identified every firm that has applied for at least one patent between 2003 and 2009.
[6] In contrast to Blind et al. (2006), we merge chemistry, biotechnology and rubbers/plastics as these are quite similar industries and thereby, we get higher number of observations per sector.

Table 1
Sector and size distribution of unbalanced sample 2002

Sector	Observations	Per cent	Average number of Employees
Mechanical engineering	118	22.18	2084
Chemistry/Rubber & Plastics/Biotech	118	22.18	4011
Consumer goods	20	3.76	2641
Metal production	48	9.02	1368
Electrical engineering	113	21.24	7033
Motor vehicles	68	12.78	20022
Construction	47	8.83	3529
Total	532	100.00	5954

Table 2
Sector and size distribution of unbalanced sample 2011

Sector	Observations	Per cent	Average number of Employees
Mechanical engineering	147	28.32	1008
Chemistry/Rubber & Plastics/Biotech	78	15.03	5075
Consumer goods	56	10.79	1165
Metal production	68	13.1	893
Electrical engineering	128	24.66	5454
Motor vehicles	23	4.43	40284
Construction	19	3.66	2367
Total	519	100.00	4511

This may be due to the fact, that the requirements for a company to be faced with the questionnaire are much looser for the participants in 2011 (one patent application within six years) than in 2002 (three patent application within one year).Due to these differences in size and sector distribution, it is not straightforward to compare our recent data to the sample from 2002. Also, we do not have exclusively identical companies in both samples and therefore miss a panel structure. In order to cope with this possible sample selection bias, we conduct a propensity score matching (PSM) to attain comparable, balanced samples. In general PSM is a statistical method to analyse the effect of a treatment on basis of two groups (treated and non-treated). The main challenge for such an analysis is the generation of two comparable groups which only differ by their treatment which, in our case, is the time-difference between the two samples. In order to achieve such groups, PSM matches treated with non-treated group members who are very similar regarding several characteristics (Carolyn Heinrich, Alessandro Maffioli, & Gonzalo Vázquez, 2010). In our case we estimate the propensity score for each observation in the two datasets by conducting a logistic regression with sample-affiliation as the dependent variable (treatment variable) and a set of different explaining variables that might be characteristic for the sample-affiliation: the number of employees as

well as dummy-variables for each sector[7]. As Blind et al. (2006) show, both variables are assumed to have an influence on the assessment of motives to patent as well as the importance of different instruments to cope with intellectual property which are the main object of investigation of our research.

Having calculated the propensity score, we are able to conduct the matching. Therefore, we apply a nearest neighbour matching without replacement which uses a so-called calliper. This calliper can be seen as some kind of tolerance level of the maximum propensity score distance of two matched observations which reduces the risk of bad matches and which is calculated as the standard deviation of the estimated propensity score multiplied by 0.25 (compare Rosenbaum & Donald B. Rubin, 1985). Consequently, we get two balanced samples comprising 411 observations each which we use to conduct our comparative statistical analyses. One has to keep in mind that we do not conduct the propensity score matching in order to cope with the issue of the classical treatment effect, but rather to show that the structure of our samples are comparable.

Structures of the balanced samples

Having coped with the problem of possible selection biases, we take a look at the distribution of our balanced samples. The results are displayed in tables 3 and 4.

Table 3
Sector and size distribution of balanced sample 2002

Sector	Observations	Per cent	Average number of Employees
Mechanical engineering	116	28.22	2084
Chemistry/Rubber & Plastics/Biotech	77	18.73	3396
Consumer goods	20	4.87	2642
Metal production	46	11.19	1369
Electrical engineering	110	26.76	7097
Motor vehicles	23	5.60	37754
Construction	19	4.62	5302
Total	411	100.00	5764

[7] Except one sector which is omitted as reference category for which we choose the sector "consumer goods".

Table 4
Sector and size distribution of balanced sample 2011

Sector	Observations	Per cent	Average number of Employees
Mechanical engineering	101	26.28	700
Chemistry/Rubber & Plastics/Biotech	77	18.73	3453
Consumer goods	20	4.87	60
Metal production	45	11.19	152
Electrical engineering	126	28.71	5455
Motor vehicles	23	5.60	40285
Construction	19	4.62	2367
Total	411	100.00	4875

First of all, it can be noted that now the number of companies per sector is very similar between the two samples and both samples are equally large. Likewise, the difference between the mean of employees between both samples has diminished. On the other hand, the average number of employees per sector has changed especially in the sample from 2011. As we have more difference in the sector-affiliation than in size between the unbalanced samples, the propensity score matching allows the difference in size between the sectors to grow in order to level the differences between the observations per sector in the balanced samples. However, as running our analyses with the unbalanced samples does not change the outcome of our statistical analyses, we do not see this fact to be problematic and believe that our results regarding the changes in the assessment of instruments to protect IP as well as the motives to patent are correct.[8]

4. RESULTS

After the sample description in chapter 3, the results of the survey will be presented in the following chapter. The analysis is based on two methodological pillars. First, as the paper is about possible changes in the motivation of German companies to apply for patents, we have to examine the standing of patents among other instruments to protect intellectual property as well as the motivation of companies to patent by using two-sample t-tests. Second, we analyse if the interplay between patent motives has changed. We use a factor analysis to identify superordinated patent motives. Based on these superordinated motives we construct a four staged index by which we measure the diversity of a company's set of patent motives. By using a multivariate ordered probit analysis, including company specific factors as well as different sector variables we explain in the last step, which factors drive the diversity of patent motives.

[8] For the sake of simplification, we do always refer to the balanced sample within the text. All results of the unbalanced samples can be looked up in the appendix.

Descriptive results – Changes over the last decade

For the analysis of the relevance of patents among other protection instruments we use information on the assessment of a five point Likert-scale by which the questioned companies could rate the importance of each instrument from 1 ("not important) to 5 ("very important"). To ensure the comparability of the samples (2011/2002) the questionnaire used the same items as Blind et al. (2006). For the analysis of the changes regarding the relevance of instruments between 2011 and 2002 a two-sample t-test was conducted. The results are provided in Table [9]. With exception of patents and trademarks, all instruments have changed significantly in relevance during the last decade. Regarding the relevance of patents to protect a company's IP, compared to other formal (trademarks, utility-patents, design-patent and copyrights) and informal (lead-time advantage and secrecy) instruments, table 5 reveals that patenting has remained the most important formal protection instrument. Nevertheless, informal instruments are still more important than patenting (Lead-Time-Advantage) or have caught up in importance (Secrecy). While the relevance of patents and trademarks has not changed, the importance of other formal instruments like copyrights and especially utility- and design patents has increased significantly in importance within the last decade.

Table 5
Ranking of protection instruments (Balanced Sample, N=411)

Instrument	2011 (mean)	N=	2002 (mean)	N=	Change (%)	T-test
Lead-Time Advantage	4.17	371	4.35	401	-4.32	↓***
Patent	4.14	409	4.08	405	1.47	→
Secrecy	4.13	373	3.55	397	16.34	↑***
Trademark	3.54	336	3.54	390	+/- 0	→
Utility Patent	3.27	350	2.54	401	28.74	↑***
Design Patent	2.31	264	1.77	364	30.51	↑***
Copyright	2.32	352	1.97	354	17.77	↑***

The mean is derived from a five point Likert-scale: 1 (= very unimportant) till 5 (= very important)
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

To get a deeper understanding of the motives to patent, firms were asked about twelve different patent motives which they should rate by their importance on a five point Likert-scale from 1 ("unimportant") to 5 ("very important"). Again, we analyse changes in the relevance of the motives between both samples by using a two-sample t-test. The results are itemized in table 6[10]. Except for the motives "protection against imitation", "exchange potential" and "earning of royalties" all patent motives are characterised by significant

[9] For the results of the unbalanced sample please see table A1 As there are no differences compared to table 1, the results can be regarded as robust.
[10] For the results of the unbalanced sample please see table A2 As there are no differences compared to table 2, the results can be regarded as robust.

changes during the last decade. Regarding their relevance, "strengthening of market position/hedging of market shares" and "protection against imitation" are the most important motives to patent. However, the first motive has significantly increased in importance while the second motive stayed constant. Both motives are by far the most important. In contradiction to these traditional and directly market-related motives, most strategic motives have lost in relevance.

Table 6
Ranking of motives to patent (Balanced Sample, N = 411)

Motive	2011 (mean)	N=	2002 (mean)	N=	Change (%)	T-test
Strengthening of market position / hedging of market shares	4.35	408	3.81	392	14.17	↑***
Protection against imitation	4.30	407	4.24	405	1.42	→
Preservation of own technological development scope	3.81	403	3.95	397	-3.67	↓*
Improving corporate image	3.54	403	3.82	405	-7.91	↓***
Preventing competitors from entering the market	3.49	401	3.86	400	-10.60	↓***
Increasing corporate value	3.28	402	3.40	405	-3.66	↓
Enhancing position in business cooperation	2.39	398	2.74	392	-12.77	↓***
Exchange potential	2.30	399	2.27	386	1.32	→
Earning of royalties	2.20	398	2.24	407	-1.82	→
Use of patents as an internal performance indicator	2.13	398	2.36	398	-10.80	↓***
Employee motivation	2.08	399	2.69	398	-29.33	↓***
Easier access to capital markets	1.85	398	2.10	384	-13.51	↓***

The mean is derived from a five point Likert-scale: 1 (= very unimportant) till 5 (= very important)
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Nevertheless, the preservation of the own technological development scope, the improvement of the corporate image, the prevention of competitors from entering the market and the increase of the corporate value are still regarded as relevant as they are rated at least "medium-important" on average. The less important motives, especially the use of patents as an internal performance indicator, employee motivation and the easier access to capital markets are characterized by the highest loss in importance. In respect to the results presented above, we can confirm our first hypothesis. Strategic patent motives have become less relevant over the last decade. In contrast, traditional and directly market-related motives like strengthening of the market position/hedging of market shares as well protection against imitation have increased in importance or at least stayed constant.

Factor analysis - Changes in the interaction of patent motives

In order to analyse if the interplay of the patent motives has changed compared to Blind et al. (2006) which indicated five superordinated patent motives (protection, blockade, reputation, exchange, incentive), we conduct a factor analysis on the twelve patent motives displayed in table 6 with an orthogonal rotation (varimax) [11] in order to test if the number of factors has changed. The sample adequacy can be regarded as very good (Kaiser-Meyer-Olkin (KMO) = .79; (Henry Kaiser, 1974)). The factor loadings after the rotation are illustrated in table 7.

Table 7
Factor loadings of motives to patent (N = 392)

Variable	Factor 1	Factor 2	Factor 3
Protection against imitation			0.7696
Exchange potential		0.7720	
Earning of royalties		0.6406	
Strengthening of market position / hedging of market shares			0.8097
Easier access to capital markets		0.6232	
Enhancing position in business cooperation		0.6351	
Preventing competitors from entering the market			0.5770
Preservation of own technological development scope			0.5458
Improving corporate image	0.7199		
Increasing corporate value	0.7215		
Use of patents as an internal performance indicator	0.6650		
Employee motivation	0.6630		
Eigenvalues	3.76	1.85	1.08
% of variance	19.83	18.72	17.27
Cronbach's alpha	0.72	0.72	0.63

Blanks represent factor loadings < .5

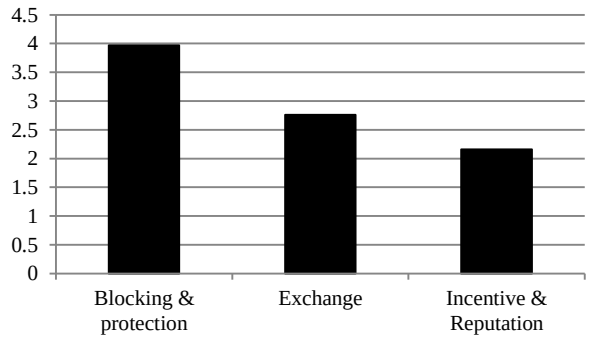
From the clustering of the items, three factors were retained which explain 55.81 per cent of the variance:

— Incentive & Reputation: improving corporate image; increasing corporate value; use of patents as an internal performance indicator; employee motivation.
— Exchange: exchange potential; earning of royalties; easier access to capital markets; enhancing position in business cooperation;
— Blocking & protection: protection against imitation; strengthening of market position / hedging of market shares; preventing competitors from entering the market; preservation of own technological development scope;

[11] Correlated factors would be problematic for further steps especially the construction of the scale for the measurement of the breadth of the patent motives.

The "traditional" and directly market-related motives are grouped together in the blocking & protection factor. From the more strategic motives two factors could be derived: the exchange factor which highlights the exchange potential regarding monetary aspects as well as the usage of patents within cooperations and the incentive and reputation factor in which the signalling and incentive functions are closely linked together. The importance of the different factors are displayed in Fig. 2.: the blocking & protection factor is by far the most important factor, with a mean of 3.99 followed by the exchange- (2.75) and incentive & reputation factor (2.18). In comparison to (Blind et al., 2006) who indicated five superordinated patent motives (protection, blockade, reputation, exchange and incentive), we received three factors from our factor analysis. These results point to a more integrated approach in companies' patenting strategies compared to 2002 as more motives to patent correlate higher with each other. Therefore we can confirm our second hypothesis.

Fig. 2.
Importance of the clustered patenting motives (N = 392)



Inductive results - Factors which drive the diversity of the patent motives

Dependent variable

The results of the factors analysis point to a more integrated use of patents compared to Blind et al. (2006). Thus, we wonder what drives the breadth of motives respectively the variety of reasons to apply for a patent. Therefore, we construct a four-stage indicator based on the factors derived from the factor analysis (Blocking & Protection, Exchange, Incentive & Reputation). The variable equals the value 3, if a firm regards all three factors as important, 2, if two factors are important, 1 if one factor is important and 0 if none of the three factors is regarded as important. To measure if a company considers a factor as important, we rely on a "relative measurement", which considers differences in the relevance between the factors (see Fig. 2). For this reason, we recode the continuous factors into binary variables by using the 75-Quantil (Q_{75}) as a border to differentiate if a company regards a motive as important (= 1) or unimportant (= 0).

Explanatory variables

Based on our hypothesis in chapter 2, we include the following explanatory variables: R&D-intensity, secrecy, patent search and trademark in the analysis as explanatory variables. R&D-intensity is a continuous variable which equals the ratio of the R&D-expenditures to the total turnover. We use the R&D-intensity and not the total R&D expenditures because Cohen, Levin, & Mowery (1987) show that the company size has no influence on the R&D-intensity. Therefore, we exclude a potential bias caused by the expected correlation between company size and R&D expenditures and avoid potential multicollinearity. The variable trademark is an ordinal variable based on a five point Likert-scale from 5 ("very important") to 1 ("not important"). We recode this variable into a binary variable. It takes the value 1, when firms regard them as very important (5) or important (4) and 0 otherwise. The relevance of patents as a search instrument is included in the variable Patent search. We also recode this variable into a dummy variable, being 1 if the company searches for information on patents at least once a month and zero if the company searches less frequently.

Control variables

We dispose different firm- and industry-level variables which can influence the patenting behaviour of companies. As several studies show (e.g. Blind et al., 2006) the company size can influence the patenting behaviour. In order to test for size effects, we include the logarithm of the number of employees (= log_emp). Furthermore, we also include the squared term (= log_emp_sq) to test for an inverted U-shape. On industry level, we include the competition intensity (= comp_int) as well as different sectors in our analysis. Studies show that both variables can have an impact on the patenting behaviour of companies and that especially the effectiveness and relevance of patenting can differ significantly between sectors and technologies (Blind et al., 2006; Cohen, Nelson, & Walsh., 2000; Lemley & Shapiro, 2005). The competition intensity is based on a five point Likert-scale ranging from 1 ("very low") to 5 ("very high"). The sectors are coded as binary variables. We differentiate between the following sectors: chemistry (including biotechnology as well as rubber and plastics), (= sec_chem), consumer goods (= sec_cg), metal (= sec_metal), electrical engineering (= sec_eng), automotive (=sec_aut), construction (=sec_constr) and mechanical engineering (= sec_mec). We use the sector mechanical engineering as a basis variable because it represents the largest sector in our sample. Table 8 gives an overview on the distribution of these variables.

Table 8
Description and means of further explanatory variables (balanced sample 2011)

Variable (acronym)	Description	Mean (S.E.)
Dependent variables		
Diversity of patent motives (breadth_mot)	Range: 0 to 3 Value 3: Very broad Value 0: Very narrow	0.72 (0.04)
Independent variables		
Patent search (pat_search)	Value 1: At least monthly searches	0.43 (0.02)
Trademarks (trademark)	Value 1: High or very high importance of trademarks as protection instrument	0.59 (0.03)
R&D-intensity (rd_int)	Percentage of R&D expenditures of total turnover	0.09 (0.02)
Control variables		
Employees (emp)	Number of employees (2011)	4874 (1654)
Employees squared (emp_sq)	Number of employees squared (2011)	
Competition intensity (comp_int)	Value 1: High or very high competition intensity in at least the national, European or international market	0.81 (0.02)

Ordered probit model

We use an ordered probit model to analyse which factors influence the scope of the patent motives. The results are presented in table 9[12]. The analysis contains a population of 252 companies. The goodness of the model with a pseudo R^2 of 0.05 can be regarded as adequate and sufficient for a valid assessment of our hypotheses.

Table 9
Drivers of the patent scope

Variable	Coef.	Std. Err.
log_emp	-0.16	0.16
log_emp_sq	0.01	0.01
pat_search	0.36**	0.16
Trademark	0.33**	0.15
rd_int	0.59**	0.24
comp_int	0.31	0.19
sec_chem	0.47**	0.23
sec_cg	-0.08	0.39
sec_metal	0.12	0.27
sec_eng	0.42**	0.21
sec_aut	0.75**	0.38
sec_constr	0.47	0.38
Pseudo R^2	0.05	
N	252	

*** p < 0.01. ** p < 0.05. * p < 0.1

Regarding the company size (log_emp & log_emp_sq), the results show that there is no significant effect on the diversity of the set of patenting motives. Therefore, we have to refuse Hypothesis 3. The R&D-intensity of a company shows a positive significant effect on the

[12] For the results of the unbalanced sample please see table A3 As there are no differences compared to table 9, the results can be regarded as robust.

scope of a company's patent strategy which supports Hypothesis 4. The usage of trademarks also has a significant and positive effect the scope of a company's patent motives. Hence, Hypotheses 5 is also supported by the data. Moreover, there is a positive significant influence of the search intensity on the scope of a company's patent motives supporting Hypothesis 6. Regarding the sectors, three of them show significant differences compared to the basis variable/sector mechanical engineering. In more detail, the sectors chemistry (including biotechnology as well as rubber and plastics), electrical engineering and the automotive sector tend to have a broader scope of patent motives than the underlying sector.

5. DISCUSSION AND CONCLUSION

During the last decade the growth rate in the number of patent applications in Germany has stagnated. Based on this phenomenon, we explored changes in the patenting motives of companies since 2002 as well as the factors which drive the diversity of company´s set of patenting motives. Looking through the lenses of a resource-based perspective as well as picking up the concept of the "anticommons", we argued that the increasing competitive patent landscape as well as the resources and competences of a company influence its patenting motives and the diversity of its patent strategy.

Different aspects are discussed at the beginning, which are relevant to consider in this discussion. First, we asked how the motives of patent have changed during the last decade. Our statistical results suggest that the relevance of traditional and directly market-related patent motives has increased or at least stayed constant while strategic patent motives have decreased drastically in relevance. We believe that this phenomenon is the result of a more fragmented patent landscape which makes it harder for companies to manoeuvre within and therefore has a negative effect on the cost-benefit-ratio of patents. As a result, companies have to choose which patent strategy to pursuit. As Somaya (2012) states: companies have to prioritize their patent related activities and the allocation of their resources involved. This might led to a streamlining process of patent strategies which result in more integrated patent behaviour of companies. The results of our factor analysis support that argument by showing, that the number of superordinated patent motives has decreased compared with the results from (Blind et al., 2006).

Our second insight concerns the diversity of a company´s set of patenting motives. Basing on a resource-based perspective, our empirical results show that the resource allocation as well as the competences of a company has a significant impact on the diversity of their set of patenting motives. In this connection, it is remarkable that the size of company has no influence. This is contradictory to further findings from Arundel (2001) and Blind et al. (2006). On the other hand, there are considerations that a company´s patent strategy is better predicted by its innovation strategy, e.g. research activities, than by Schumpeterian factors like firm size (Peeters & de La Pottelsberghe Potterie, 2006). However, the R&D-intensity increases the diversity of a company's set of patenting motives. This mirrors the fact that companies which invest significant resources into the creation of new knowledge need a broad patent strategy to protect their innovations, motivate their employees, communicate their inherent knowledge and hence recoup their investments. Furthermore,

competences to monitor the technological landscape influence the diversity of a company's patent strategy. More precisely, companies which regularly search for information in patents pursuit a more diverse patenting strategy. Last, the relevance of trademark protection leads to a broader set of patenting motives. This might be motivated by the complementary use of patents and trademarks as well as the reputation effect both instrument contain.

The findings of our study have two important implications for the ongoing discussion on strategic patenting: First, it reveals significant changes in the patent landscape. A multitude of research has highlighted the increasing relevance of strategic patent motives. Our works points into a direction which makes it necessary to overthink the general relevance of such motives. On a more general level the results indicate that companies have reflected on their patent strategies and that an adjustment process took place which steers the patent system back to its original functions. Secondly, actual studies within the field of strategic patenting do not respond to the question which factors drive the diversity of a company's set of patenting motives. By using a resource-based perspective, we pushed the discussion in a new direction which is especially relevant on a practical level. As mentioned above, companies have to rethink their patent strategies. The study at hand shows that the resource allocation as well as the competences of a company set the cornerstones on which a company should adjust the diversity of their patent strategy.

One of the major limitations of our analysis is the missing panel structure. Even though we use a propensity score analysis to make both samples comparable our analysis still implies a potential samples bias. Regarding the analysis of the diversity of the patent motives, the results explain a certain amount why company´s rely on a broad patent strategy. Nevertheless, additional variables are missing which explains the low explanatory power of our model.

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Appendix

Table A1
Ranking of protection instruments (unbalanced samples)

Instrument	2011 (mean)	2002 (mean)	ttest
Lead-Time Advantage	4.19	4.36	↓***
Secrecy	4.10	3.58	↑***
Patent	4.15	4.08	→
Trademark	3.60	3.55	→
Utility Patent	3.34	2.55	↑***
Design Patent	2.47	1.73	↑***
Copyright	2.39	2.00	↑***

The mean is derived from a five point Likert-scale: 1 (= very unimportant) till 5 (= very important)
*** p < 0.01. ** p < 0.05. * p < 0.1

Table A2
Ranking of motives to patent (Unbalanced Samples))

Motive	2011 (mean)	2002 (mean)	ttest
Strengthening of market position / hedging of market shares	4.37	3.80	↑***
Protection against imitation	4.33	4.26	→
Preservation of own technological development scope	3.82	3.96	↓*
Improving corporate image	3.54	3.82	↓***
Preventing competitors from entering the market	3.49	3.83	↓***
Increasing corporate value	3.28	3.41	↓*
Enhancing position in business cooperation	2.36	2.82	↓***
Exchange potential	2.35	2.30	→
Earning of royalties	2.20	2.30	→
Use of patents as an internal performance indicator	2.17	2.41	↓***
Employee motivation	2.11	2.72	↓***
Easier access to capital markets	1.89	2.14	↓***

The mean is derived from a five point Likert-scale: 1 (= very unimportant) till 5 (= very important)
*** p < 0.01. ** p < 0.05. * p < 0.1

Table A3
Drivers of the patent scope (unbalanced sample)

Variable	Coef.	Std. Err.
log_emp	-0.12	0.15
log_emp_sq	0.01	0.01
pat_search	0.41***	0.14
Trademark	0.34**	0.13
rd_int	0.55**	0.23
comp_int	0.18	0.17
sec_chem	0.26	0.20
sec_cg	-0.10	0.23
sec_metal	0.10	0.21
sec_eng	0.10	0.17
sec_aut	0.22	0.36
sec_constr	0.27	0.36
Pseudo R^2	0.05	
N	252	

*** p < 0.01. ** p < 0.05. * p < 0.1