Motives to patent: empirical evidence from Germany

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Abstract

Against the background of the patent upsurge, we analyse first the role of patenting and alternative instruments to protect intellectual property, based on a sample of German companies active in patenting. In a second step, we investigate the motives to patent, considering sector and company size effects. We find that company size matters, both for the importance of instruments and the motives to patent. Especially the importance of the new strategic motives to patent, like using patents to improve the own position in negotiations with partners, licensees and the financial sector, or to use patents as incentives for R&D personnel or performance indicators correlate positively with company size. Based on these insights, we derive some policy conclusions.

Keywords: Patents, R&D, Competition, Protection, Appropriability

1. Introduction

A phenomenon of the 1990s which we observe for several European countries, but also the USA and Japan, is a strong increase in patent applications, whereas the private expenditures for R&D have grown only modestly. Consequently, the patent intensity defined as patent applications per R&D expenditures increased significantly. Several explanations for this phenomenon are provided in the literature. First, it is argued that the R&D process became more efficient or more differentiated, leading to a higher number of inventions and therefore patents per R&D expenditures (Janz et al., 2001). Second, the patentability has been extended to promising and expanding new fields of technology like biotechnology (e.g. Thumm, 2003) or 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 (Schmoch, 2003).

The literature analysis revealed definite evidence of the increased significance of patenting in general and the changing pattern of motivations to use patents, which confirms the relevance of the present study. Despite all differences in single cases, it became clear that patent utilisation has increased. Although all the works discussed took this development as their starting point, they arrive at widely differing conclusions as to the driving forces behind it. On this basis, we must agree with Jaffe's judgement (Jaffe, 1999), whereby a multiplicity of explanatory factors flows in and the individual contribution of each to the explanation must remain unclear, it is an important point of departure for this investigation. Therefore we have chosen a very broad approach in this paper. Most of the works discussed also postulate that the motives for patenting have widened and shifted. The discussion of the empirical studies on the significance of strategic patenting once again confirmed the relevance of strategic patenting and differentiated still further. The present paper goes further than these contributions:

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(1) It examines the developments of the late 1990s and the beginning of the 21st century, which presents an indispensable broadening of the existing and frequently cited analyses of strategic patenting in the early 1990s (Arundel et al., 1995; Cohen et al., 2002; Schalk et al., 1999) in view of the dynamic developments in the second half of the 1990s.
(2) In addition, the analysis is based on a relatively broader and more systematic sample than all studies discussed here. For the first time, a full survey of all companies significantly involved in patenting was performed here, taking one country – Germany – as an example. All enterprises which are responsible for strategic patenting in Germany were addressed in the survey.
(3) Finally, the survey content is broader and structured in a more differentiated manner. Individual motivations were asked for in the survey. In addition, we revealed several further explanatory variables, such as cooperative behaviour, competitive intensity, R&D intensity or the use of searches in patent databases.

We will focus in our paper on the strategic aspect of patenting, contributing additional insights to the literature reviewed in Section 2, which reveals that there are several shortcomings and gaps in previous analyses. We concentrate on the last argument by analysing a survey among German companies active in patenting. The main hypothesis of the paper is that patents are more and more used for strategic objectives and the relative relevance of the traditional protection motive has been reduced. From this hypothesis we derive the second hypothesis of a converging pattern in the motives to patent across sectors, because the technology- and therefore sector-related protection motive loses importance, whereas competition- and cooperation-related driving forces for patenting become more important. This contrasts the results focusing on sector differences observed by Cohen et al. (2002) in the USA and Japan in the early 1990s. This second hypothesis leads to the third hypothesis, that company size is a factor which is still an important dimension to differentiate between patenting strategies, e.g. large companies use patents for rather different purposes than small companies.

The remainder of the paper is structured as follows. First, we present a review of the literature focusing on strategic patenting, second, we characterise the database and provide some descriptive statistics about the importance of various protection instruments and the various motives to patent especially highlighting the differences between sectors and companies of different size. Third; we perform multivariate Probit models including further company specific factors to explain the relevance of the various clusters of patenting motives. Finally, we conclude with some policy conclusions.

2. Review of the Literature

The studies which discuss the upsurge of patent applications in the 1990s have increasingly examined the driving forces which are not connected with input, output and organisation of R&D in the narrower sense, but with the *strategic* benefit of patents. What Hall and Ziedonis (2001) describe as improved IPR management is not only a rounding off of existing practices to increase efficiency; the object of such studies is rather a change in the significance of patents, which has led, on the one hand, to a growth in importance of IPR management and to an extension of the target definition of IPR management which achieved independence from the R&D management in the narrower sense.

The strategic motives which were discussed in the literature are very diverse. The consequences of strategic patenting are in every case that the decision to patent – despite the significance of the protection motive – is in part uncoupled from the technological necessity to protect the own invention from imitation by other market participants, or that the strategic behaviour of other market participants is taken into account and that patents serve increasingly as new sources of revenues.

Although the question of strategic patenting has become increasingly important in the past years, the number of empirical studies on the driving forces behind patenting is still relatively low (Arundel and

Patel, 2003). Besides the already mentioned studies of Cohen et al. (2002) and Arundel et al. (1995), and the OECD survey (OECD – Committee for Scientific and Technological Policy, 2003), three further recent studies must be named. Duguet and Kabla (1998) analyse a total of 299 observations of French enterprises, based on the French "Enquête Appropriation" (study of protective behaviour) conducted in 1993. For Germany the Ifo Institute carried out a survey on the diffusion of knowledge in the year 1997, which also contained the question of the motivations for patenting (Schalk et al., 1999).[1] In an investigation of Japanese and British enterprises Pitkethly (2003) analysed the significance of patents as a source of information and as direct source of income (licences) and in this context also inquired about the importance of various patent functions.

The core motive to patent is the protection of own inventions from imitation, i.e. the traditional patent motive. The strategic motive, which is in the forefront of most investigations, is to block competitors. Two versions are differentiated here. *Offensive* blockade is the case when firms patent in order to prevent other firms from using their technical inventions in the same or adjoining application fields, i.e. to keep other s from using the technology, even though there might be no direct interest in using the content of such patents. This means that patent walls are erected around the own invention, it is more broadly patented than necessary to protect the actual technical invention. *Defensive* blockade is the case when firms patent in order to prevent their own technological room to manoeuvre being reduced by the patents of others (Arundel and Patel, 2003; Kingston, 2001). This includes the often discussed motive to prevent patent infringement lawsuits by third parties by possessing own patents (Arundel et al., 1995; Cohen et al., 2002).

Besides these two central motives, the number of further imaginable strategic motives is considerably larger, and the existing recent analyses deal with these motives in different ways. Among others, patents are regarded as indicators to assess and reward R&D personnel, sources of licence income, exchange potential (or negotiation material), international market extension, reputation or technological image, the pressure to patent due to the IPR behaviour of other enterprises and in order to enforce own standards (Blind and Thumm, 2004).

In all the studies, the traditional question of protection from imitation is also posed in order to estimate the relative meaning of the strategic motives. In addition to the motives discussed above, four of the five studies inquire about the significance of patents as exchange potential (alternatively, as negotiation material in inter-company negotiations and cooperation) and as indicators or motivators of internal performance. On the other hand, the importance of patents for the image (or the external assessment of the enterprise) and for opening up international markets has so far not achieved any great significance in the studies.

In *all* the studies discussed here the classical motive of protection from imitation was the most important. In the study with the broadest geographical coverage by Arundel et al. (1995) from the year 1993, 80% of the enterprises stated that protection from imitation is very important or extremely important in patenting (products). The two most important *strategic* motives here are the improvement of the position in negotiations with other enterprises and preventing infringement lawsuits by third parties.[2] Licensing income, foreign markets and the internal evaluation of R&D productivity play significantly smaller roles.[3] All motives were ranked as more important for the patenting of products than for the patenting of processes, but the sequence of the motives remained the same for both products and processes. The meaning of the strategic motives increases not only with the company size, but also with the R&D intensity, while

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[1] However, the results of the Ifo survey are, on the one hand, five years older than those of the present study and so do not cover the massive expansion phase in patenting. On the other hand, the basic population deals with somewhat different target groups. The Ifo sample also contains a majority of actively patenting enterprises, whereas the sample of our study concentrates exclusively on enterprises active in patenting and has an intentional bias towards the large patent applicants, in order to take a close look at those enterprises in any case which are mainly responsible for the increases in patent numbers.

[2] Approximately 47% or 45% of those questioned evaluated the motives as important or very important.

[3] The shares of those who classify these motives as important or very important lie at ca. 15%, 10% or 8%.

the export intensity did not present a differentiating quantity. With reference to sectors, it stands out that the computer branch and the telecommunication branch quote negotiations and the prevention of patent infringements by third parties as the most important motives, even more important than protection from imitation. At the same time, the motive of negotiating is obviously more important for the electro-technical industry than the rest of the manufacturing sector. Arundel et al. (1995) finally showed the results of three countries. By comparison with the enterprises from Italy and Great Britain, the ranking of motives occupied a middle position for the German enterprises, only the licensing income and access to the international market was of greater significance to the German enterprises than the Italian or British.

In their USA–Japan comparison, Cohen et al. (2002) come to the conclusion that the sequence of motivations not only for patents on products but also for patents on processes is practically identical in the enterprises in both countries: protection from imitation before offensive blockade, defensive blockade, negotiation mass, reputation, licensing income and internal performance indicator.[4] In contrast to the investigation of European enterprises performed by Arundel et al. (1995), the function of improvement in negotiations was of less importance here. It is further striking that all *strategic* motives (not protection from copying) are much more widespread in the Japanese enterprises than in the US ones. At the same time, the Japanese enterprises are less characterised by a strategy of ensuring exclusiveness than by the fact that despite the possibilities anchored in the Japanese patent system of aggressive patenting and cross-licensing, they utilise patents to maintain their technological room for manoeuvre (offensive blockade).

The most important message by Cohen et al. (2002) however stems from the observation of the sector differences. The industries, in particular the electro-technical industry, for which the number of patents per market-exploitable innovation is large (so-called "complex product industries"), make considerably more strategic use of patents than the rest of the manufacturing sector ("discrete product industries"). The authors see the main reason therein, that for the introduction of a new product in "discrete product industries" the patents of other market participants do not play a role, or only a small one, whereas in "complex product industries" utilising patents of others is indispensable. Accordingly, the use of patents in the "complex product industries" is principally designed to establish negotiating mass for cross-licensing and negotiations, while the enterprises in the "discrete product industries" attempt to block out competition offensively by erecting patent fences, i.e. to prevent the developments on substitutes by a number of patents around the own actual invention. Roberts (1999) argues along similar lines, also Kash and Kingston (2001). The latter allot patents other functionalities in complex technologies compared with simple technologies. Patents become a "currency" in the market for technological modules and knowledge. Patent portfolios serve to scare off new market entrants who are reliant on the partial systems of other suppliers, but have not been able to build up currency reserves themselves. Reitzig (2004) also finds based on a data set of European patents, that patent fences in "discrete technologies" are used to exclude competitors, whereas in "complex industries" patent thickets are exchange forums for complementary technology.

The investigation of 299 French enterprises from 12 sectors (Duguet and Kabla, 1998) revealed the outstanding significance of protection from imitation. Of the strategic motives inquired about, two are striking, namely the defensive blocking and the improved negotiation position, which were both named by 62% of all enterprises as reasons for patenting. By contrast, the other three motives, income from licences (28%), foreign markets (25%) and incentives for researchers (18%) fall back sharply. This means that for French enterprises securing own technological room to manoeuvre is the decisive driving force behind strategic patenting, which was also statistically confirmed by some regression calculations.

The ranking of the reasons for patenting by German enterprises which the Ifo Institute investigated in its survey in 1997 can be presented as follows (Schalk et al., 1999): exclusive exploitation, defensive blockade, offensive blockade, improvement of negotiation basis, motivation of the staff, technical image

[4] A deviation of the Japanese enterprises from the total sample occurs because they rank reputation lowest.

and licensing income.[5] Interesting is less the sequence itself, rather the differentiation of the enterprises into "successful" innovative and "not successful" innovative[6] enterprises. The innovative enterprises generally allocate higher significance to all motives, which is hardly surprising, given the higher utilisation of patents by innovative enterprises. Among the innovative enterprises, again the successful enterprises showed for all motives – except negotiating position and licensing income – higher importance. That means that the innovation success of enterprises is correlated according to these data also with the significance which the enterprises accord to their patent strategies.

The current OECD survey (OECD – Committee for Scientific and Technological Policy, 2003) does not differentiate according to strategic motives and other influential factors to account for increased patenting. If however the strategic motives are isolated, an interesting extension emerges which can be explained with the "patent race" of the 1990s. It is important for the classification of these results that the enterprises were questioned about the change of significance of the motives in the last ten years. The greatest increase in significance by far was for the motive that the firms feel themselves forced to extend their activities in view of the patenting of other market participants (Roberts, 1999). Here is seen, at least for the very large enterprises that actively engage in R&D, how independent patenting dynamics has meanwhile become and accordingly also cut loose from the R&D activities. After a large gap, the increased utilisation of patents to build up negotiating power is found in second place and the technologically driven defensive blockade comes in third place only. Although the enterprises surveyed are very large, traditionally internationally active firms, the increase of international patenting takes fourth place, i.e. the internationalisation of protective activities is again increasing, to a limited extent. The growth of direct monetary returns through licensing revenue are named in fifth place, although over 40 enterprises state that the number of licences awarded to other enterprises has risen in the last ten years. The significance of the evaluation of the enterprises as a reason to patent has grown least in the last ten years. Table 1 provides an overview of the coverage and ranking of the various strategic motives in the respective surveys.

Table 1
Ranking of the significance of motives to patent in recent empirical studies

The most visible sign of the increased significance of strategic patenting is the response that strategic patenting has found in management literature. For instance, Granstrand compiled a research programme on intellectual property that combines empirical surveys of trends in strategic patenting (taking Japanese and Swedish enterprises as examples) with conceptual and operative elements (Granstrand, 1999). The sub-title "Towards Intellectual Capitalism" makes clear how directly the question of intellectual property is bound up with competitiveness. Granstrand actually suggests a change of the economic activity, which he increasingly sees as based on intellectual property (and the effective management thereof). In such studies the connection between innovation and ability to innovate, on the one hand, and patenting, on the other hand, is no longer the centre of attention, but the question is how with given innovation activities the benefit of the results can be maximised by the intelligent management of the ensuing intellectual property rights.

3. Survey Results

3.1. The Sample

[5] This result contrasts somewhat with the greater significance of licensing for German enterprises compared to that of British and Italian enterprises seen in the study of Arundel et al. (1995), see above.

[6] Innovative enterprises were determined by means of a complex index in which numerous variables on the technological competitiveness, on internal R&D and know-how were included (see Schalk et al., 1999, p. 47ff).

Based on the results of the analysis of applicants, all German enterprises, more than 1500, which had applied for a minimum number of three patents in 1999 were contacted via a paper questionnaire in the year 2002. Due to great interest in the subject, a response rate of over 33% and thus over 500 completed questionnaires were attained. The companies participating in the survey are responsible for more than 40% of all German applications at the European Patent Office or PCT procedures for the year 1999, covering a high share of very large, actively patenting companies.

The previous examination of the enterprises according to technology areas resulted from the construction of the sample via patent searches. The sector-related analysis of the sample is however carried out on the basis of the classification according to industrial sectors (self-estimate of the respondents), because here the assignment of the firms is more definite and because comparisons with other sector-related indices are possible. The industrial branches are divided into seven sectors, of which chemistry (incl. pharmaceuticals and biotechnology), vehicle construction, electrical engineering (incl. measurement, instrumentation, control, optics and medical technology), mechanical engineering, as well as the related area of metal-producing and metal-working are the main focus of interest. In addition, the three sectors building, mining, wood, stone and earth are summarised in construction as a kind of residual sector, food, textiles and furniture into consumer goods are taken together. The approach is based on similarities between these sub-sectors and required by the need to generate sufficient numbers of observations per sector.

Table 2
Sector and size distribution of the sample

3.2 Use of Protection Instruments and Motives for Patenting

After having described the sample and its characteristics in the above section, the results of the survey are presented and interpreted in the following chapters. This will be done for the sample and also differentiated according to size categories and for branches. This chapter explores first of all the meaning of the various protective mechanisms to protect the inventions and innovations, in order to be able to position the status of patents as a formal property right in the context of diverse strategies and instruments. The examination and discussion of the motives to use patents follows. Proceeding from the significance of various motives and motive clusters in the present study, based on the reported changes in the individual reasons, a first assessment is possible of the influence on the development of the application statistics in the recent past. We conclude this section with a multivariate analysis in order to explain the importance of the various motives to patent, taking sector, company size and other influencing factors into account.

3.2.1 Significance of various protection mechanisms

The central initial hypotheses of this study state that patents are more and more an instrument to secure the competitive advantage. In order to test these hypotheses, the firms were asked about the meaning of eleven different protective strategies and the change in them. These protective mechanisms can be classified into one of three groups:

- *patent strategies:* domestic applications, applications abroad,
- other *formal protective rights:* trademark protection, utility patent, design patent, copyright, as well as
- *informal or contractual protective strategies*: measures to keep personnel long-term, confidentiality, time lead over competitors, exclusive customer relationships, form of contracts with suppliers.

The division into these three groups follows on the one hand a differentiation according to content as already used in other works examining similar questions (Rammer, 2003; Cohen et al., 2002), whereby the division into patent strategies and further formal protection rights at this point is owed to our analyti-

cal goals, while in both cases we are dealing with forms of formal protection rights. On the other hand, this tripartite division is closely connected to the patent focused hypotheses we try to investigate.

It is not surprising that for companies active in patenting, patenting has an outstanding position among all protection strategies aimed to improve the protection of own asset items and to appropriate the economic benefits from this. Patent strategies (domestic patents and patents abroad) are assessed by more than 70% of the companies to be important or very important on a scale from 1 (low importance) to 5 (high importance). This share is higher than for all informal protection strategies, with the exception of trying to achieve a lead time advantage, which is assessed to be important or very important by almost 90% of the respondents. By contrast, the meaning of the other formal property rights is clearly lower (trademark, utility patent, copyright, design patent).

Table 3
Importance of protection instruments (share of companies giving high or very high importance)

The two following sections differentiate the analyses of the importance of patents as protection instruments according to sectors and company sizes.

In evaluating the relevance of patents in comparison to the two other groups of instruments, only few branch-specific differences can be discovered (Fig. 1). All sectors attach the greatest importance to the patent strategies, followed by informal protective mechanisms and – after a great interval – other property rights. However, multiple-comparison tests with the Bonferroni adjustment reveal that not even the difference between the "construction" sector and the chemical industry is statistically significant.

Fig. 1. Importance of patenting as protection strategy differentiated by sector
(share of companies giving high or very high importance)

A theoretical initial supposition in investigating the relevance of protective mechanisms according to firm size classes is that patents are relatively more important for smaller enterprises than for larger ones, because smaller enterprises with reference to alternative protection mechanisms and appropriation appear at a disadvantage, compared with the large firms (Arundel et al., 1995). In numerous studies (Kortum and Lerner, 1999; Janz et al., 2001; Bussy et al., 1994; Arundel et al., 1995) this thesis was however clearly refuted and it was determined that the importance of patents grows with the increasing company size. The reasons for this are of an institutional and competitive nature.

On the one hand, large enterprises are capable of carrying out specific functions within their own organisation. Our survey reveals that the connection between size and the existence of patent departments is almost linear. Large enterprises as a rule have own patent departments with patent attorneys and engineers. The organisational units support the patent process not only passively and if requested to by the R&D departments. Rather, in many cases they are actively involved in the R&D projects, and endeavour to recognise patent potentials early on and draw the attention of the developers to patenting possibilities.[7] As the patent departments recover at least a large part of their costs also through licensing fees and must justify their activities by means of high numbers of applications, an institutional or personal interest to maximise the activities in or revenues from patenting exists, which tends to lead to an expansion of patents. This is also unambiguously confirmed in the differentiation of the results of the survey according to the function of the person answering. Patent officers attribute greater importance to patents at home and abroad than R&D officers.

Fig. 2 presents the shares of companies giving patenting a high or very high importance as protection strategy in our survey. We observe statistically significant differences between the small (1–249 employees) and the medium (250 to 1999 employees) in contrast to the very large companies (more than 2000 employees) (see Table A2 in the Annex).

[7] These conclusions stem from company interviews in various studies of the Fraunhofer ISI (Blind et al., 2003; 2005).

Fig. 2. Importance of patenting as protection strategy differentiated to company (number of employees)
(share of companies giving high or very high importance)

Taking the results of Fig. 1 and Fig. 2 and the multilateral statistical tests together, we have to conclude that the importance of patenting as a protection strategy is equally relevant for companies in all sectors, whereas the very large companies attribute a statistically significant higher importance to this protection instrument than the small and medium-sized companies. This observation is a first confirmation of our hypothesis that sector differences in patenting are less relevant, whereas company size aspects are still persistent.

3.2.2 Motives for patenting

After the presentation and discussion of the use of different protective strategies in general and patenting in particular, in this section the motives to patent are presented and analysed. The hypothesis is that the motives for patenting have broadened and that those motives which can be described as strategic and which do not in the narrower sense serve to protect a specific invention, have gained in meaning.

Starting point for the development of the patent systems was the economically motivated target, to strengthen the incentives for private R&D expenditures and to accelerate the diffusion of new technical knowledge, in that the patent-holders were awarded the exclusive utilisation rights for a certain period and in return they had to disclose the content of their technical invention. Besides this intentional motivation of patent protection, further motives emerged which induced the enterprises to apply for patents for their inventions. The firms were asked about the importance of 15 motives in our survey. These covered all the reasons discussed in Section 2 already dealt with in other studies. Some motives, like the differentiation according to markets, standardisation activities, the separation of technological image and enterprise value, are being systematically jointly tested for the first time.

These motives for patenting are lined up in the sequence of the share of companies giving them a high or very importance in Table 4. Top of all motives is the protection from imitation or conversely, the enjoyment of exclusive utilisation rights. The patent system therefore fulfils its original purpose. Further patents support the safeguarding of market shares in national and European markets. Patents also have great importance in safeguarding the own technological room to manoeuvre against the competition (defensive blocking) and to hinder competitors in applying technological developments (offensive blocking). The final motivation in the top five reasons for patenting is the improvement of the technological image. Safeguarding extra-European markets and the growth of value of the enterprise still achieve a share above 50% among the responding companies. Of less importance for patenting are considerations geared to improve the position in company cooperations, for cross-licensing or in the capital market. For the internal purposes of motivating staff, patenting also possesses under-average significance. Among the motives with the least importance is patenting to generate license fees and to influence standardisation activities. In addition, patents play for the average of the whole sample hardly any role as performance indicator.

Table 4
Importance of motives to patent (share of companies giving high or very high importance)

If these general results are placed in the context of earlier national and international investigations which were already discussed in the literature overview, the following similarities and differences can be noted. The Ifo study (Schalk et al., 1999) conducted in 1997 best permits a direct comparison because at the beginning of the expanding patenting activities approx. 300 German firms for which patents were of relevance submitted an estimate of different reasons to patent. The ranking of the reasons according to their importance corresponds to our results in that exclusive utilisation or the protection from imitation is in first place, followed by defensive and offensive blocking. The “technological image” has also experienced a significant increase in importance since then, while patenting to improve the negotiating position

in cooperations in 2002 compared with 1997 has lost ground, not only absolutely but also relatively. The reasons to utilise patents to motivate employees and to generate licensing income achieved a relatively small importance which corresponds to our present ranking.

The results of the European PACE study of the year 1995 (Arundel et al., 1995) can only be compared with the present results with qualifications, because there the differentiation of the motives is very limited. Protection from copying is here by far the most important patenting motive, followed by the improvement in the negotiating position and protection from patent infringements (defensive blocking). The motives generation of licensing income, entry to foreign markets and assessment of R&D staff were very important for less than 20% of the firms, which lastly corresponds also with our present results.[8] Finally, the American-Japanese comparison by Cohen et al. (2002) from the year 1994 must be mentioned. Protection from imitation was the number one reason for patenting for the American and Japanese enterprises, followed by the offensive and defensive blocking of competitors. If this result is also viewed in the context of the Ifo study, which attributes a significantly higher meaning to defensive blocking, then it can be stated that the results of our survey point out that the German companies in their strategic patenting motives have grown close to the American and Japanese firms in the meantime. With reference to the other patenting motives, the results of Cohen et al. (2000) and the Ifo study (Schalk et al., 1999) are very similar, i.e. the improvement of the negotiating basis is an essentially more important motive for patenting than image aspects or licensing incomes, which again underlines the meaning attached to image and enterprise value in the present study.

Comparing the present results with earlier studies (see Table 1) makes clear firstly that our survey covered the thematic complex in a much broader and more differentiated manner than the comparable studies. As a result it must be established that the traditional motive of protection from imitation supported by the patent system, respectively the exclusive utilisation, generally have special emphasis. However, since 1997 a gradual approximation to the strategies of American and Japanese enterprises has taken place, concerning the offensive blocking of competitors via patents. Furthermore, the German firms have recognised patents as an instrument to improve their technological image, but have obviously undertaken a change of strategy, in the sense of utilising patents less in negotiations with other firms.

A factor analysis was conducted in order to identify the dependencies between the patenting motives and to condense the differentiated multiplicity of motives in a meaningful manner, which resulted in the following grouping of motives:[9]

- *protective motives*: protection from imitation, safeguarding national, European and international markets,
- *blocking motives*: blocking *competitors* defensively and offensively,
- *reputation motive*: improvement of the technological image, increase in company value,
- *exchange motive*: *amelioration* of position in cooperations, improved access to the capital market, exchange potential, licensing income,
- *incentive motive*: motivation of staff, internal performance indicator.

The groups generated by the factor analysis correspond very well to the motive clusters discussed in the literature. The traditional protective motive is complemented by the aspect of safeguarding markets. The defensive and offensive blocking motives are grouped together in one cluster, as both motives in the narrower sense arise from the need to display own technological development possibilities. The image and company value increases are closely linked together. On the other hand, the exchange motive brings

8 Although in the international comparison the German enterprises in Arundel's study attached the greatest importance to licensing income (and market extension internationally).

9 Due to the low importance of the influence on standardisation and the consistency of the factors, this reason for patenting was not considered in the factor analysis. The five factors explain 64% of the total variance.

all the reasons together which have to do with possible partners of the firm. Among these are cooperation partners, capital investors, competitors and licensees. For internal purposes patents are used not only for motivation, but also to judge the performance of R&D departments.

Fig. 3 makes even clearer that, for the whole sample, the traditional protection and blocking motives for patenting are indeed the main focus. The reputation motives attain almost the same level of importance. Exchange and incentive motives have a high or very high meaning for less than 60% respectively 40% of the companies. This is an astonishing result, in view of the clear growth of technology exchange between firms discussed in the literature (representative for many, see Cohen et al. 2002) and in the OECD survey (OECD – Committee for Scientific and Technological Policy, 2003).

Fig. 3. Importance of clustered patenting motives (share of companies giving high or very high importance)

After the discussion of patenting motives on an aggregated level, branch-specific differences will be dealt with in a first step (see Fig.4). Basically, it appeared that significant differences between branches can only be determined in some specific cases based on multiple-comparison tests applying the Bonferroni adjustment (see Table A1 in the Annex). Protection from imitation is far and away the most important reason to patent for all sectors. Only for the chemical and mechanical engineering sector do we find a higher share of companies compared to the construction sector. As far as blocking reasons are concerned, the share of respondents from the construction sector giving a high or very high importance to the pair of blocking motives is significantly lower than all other sectors with the exception of the consumer good sector. The bundle of reputation motives is obviously equally of secondary importance among the sectors. Moreover automobile companies patent obviously in order to improve their technological image. The various motives to patent in order to improve the own position in relation to others, e.g. competitors, cooperation partners or banks, is especially important for the chemical industry, but the difference is only statistically significant in relation to companies in metal production. This results contrast Cohen et al. (Cohen et al., 2000), who postulate that the exchange motive is more prominent in “complex” industries than in “discrete” technologies. The explanation for this discrepancy can be explained by the shift of the chemical industry towards a more “complex” industry e.g. by the increasing importance of biotechnology within the sector and the increasing importance of the information technology. Finally, the importance to use patent as performance indicator or for motivating the employees is for less than 40% of the companies of high and very high importance. Sector differences do not exist. In summary, the bilateral comparison of the shares of companies attributing a high or very high importance to the bundles of patenting motives reveal that only in specific motive categories, especially in the bundle of blocking motives, can significant sector differences be observed. In general, we cannot detect any significant sector differences.

Fig. 4. Share of companies giving a high or very high importance to the grouped patenting motives differentiated by sector

Company size is a further differentiating criterion for the discussion of the importance of patenting motives, especially in view of the fact that the branch analysis revealed relatively homogeneous and further converging patterns and that in the preceding depictions and analyses the company size is presented as an important factor. While we cannot detect any significant size effects in the traditional protection and blocking motives, diverging patterns appear in the three remaining motive groups (see Table A2 in the Annex). For small enterprises (1–249 employees), patents are obviously more important for building up a reputation than for medium-sized and larger enterprises (Cohen et al., 2000), while the small and the very large companies (more than 2000 employees), by contrast to the medium-sized enterprises, apply for patents above all in order to generate licensing income, build up exchange potentials and improve their position in cooperations. Finally, with increasing company size the use of patents to motivate employees and as an indicator of performance also increases, which suggests itself in view of the differentiated R&D and patent structures. However, only the assessment of the very large companies (more than 2000 employees) differs significantly from the rest of the size classes.

The results show clearly that the company size is decisive for the assessment of the patenting motives, especially for the new strategic motives reputation, exchange and incentive. It is striking thereby that the small and large firms above all attach a greater meaning to the sum of all motives than the medium-sized enterprises. In contrast, sector differences can only be observed in the motive to block competitors.

Fig. 5. Share of companies giving a high or very high importance to the grouped patenting motives differentiated by company size

4. Factors Influencing the Motives to Patent: A Comprehensive Approach

In order to complete the analysis of the motivations to patent, we performed a multivariate Probit analysis, which allows us to control both for size and sector effects simultaneously. Furthermore, we postulate some further hypotheses about driving factors of the various motives to patent.

As already mentioned in the literature survey, there is a strong tendency to use patent portfolios as an instrument to increase competitiveness of the own company. Therefore, we derive the following hypothesis:

H1: The higher the intensity of competition, the higher the likelihood to patent in order to protect the technological assets from imitation and to secure national and international market shares, but also to block competitors offensively and defensively in their technological activities.

Patents are also more and more important in cooperations with other companies, e.g. competitors, but also suppliers and customers, and research institutes. Therefore, we conclude the following hypothesis:

H2: The higher the likelihood to cooperate, the higher too the likelihood to patent in order to improve the position in such cooperations.

The R&D expenditure, especially R&D personnel, is the major input factor for the R&D process and the R&D output of a company. Consequently, we derive the following set of hypotheses:

H3: The higher the share of R&D personnel of a company, the higher the importance to protect the results of the R&D activities also via patent protection:

- to patent in order to increase the value of the company by securing the intangible assets of the company,
- to improve its technological image via a large patent portfolio,
- to patent in order improve the own position in relation to cooperation partners, but also the financial sector, and to generate licensing revenues,
- to use patents as performance indicators and as incentives for R&D employees.

The existence of a patent, or more generally of an IPR department has certainly positive impacts on the assessment of the importance of the various patenting motives. In our approach, we differentiate two functions of a patent department. First, we focus on the competence to apply patents with other patenting companies, which is just a patent-related extension of the general cooperation frequency. Second, patent departments are able to perform searches in patent databases.

Cooperations in patenting activities, i.e. co-patenting, is a recent emerging trend. (Frietsch, 2004). These cooperations also have implications on the motives to patent. Subsequently, we derive the following hypothesis:

H4: The higher the likelihood of co-patenting activities, the more important it is:

- to protect the own technological base by patents,
- to secure own technological flexibility by patents,
- to have an excellent technological image to attract attractive cooperation partners,
- to improve the own position, e.g. in cross-licensing negotiations, by applying for patents.

Patents are also a valuable source of information related to own R&D and innovation activities. The use of patent searches to achieve information about the state-of-the-art in one's own technological area also has implications for the various motives to patent. Consequently, we derive the following hypothesis:

H5: The higher the frequency to search patent databases, the higher the likelihood to patent:

- in order to block the competitors because of the in-depth knowledge of their patenting activities,
- in order to increase the value of the own company because of the in-depth knowledge of the patenting activities of their competitors,
- in order to improve the position of the own company relating to cooperation partners, in licensing negotiations and in the capital market because of the in-depth knowledge of the patenting activities of their negotiation partners and in the technological field in general,
- in order to use patents as incentive and performance indicator because of the in-depth knowledge of the patenting activities of their competitors, which can be used as benchmark indicators.

Finally, we have to acknowledge that technology is increasingly an attractive object for marketing activities. Trademarks especially play a crucial role in the marketing mix of a company, but meanwhile also in the process of marketing innovations (Schmoch 2003; Mendonca et al. 2004). If a company has a dedicated marketing strategy to protect its innovations by registering trademarks, then such a strategy also has implications for the motives to patent. Consequently, we derive the last set of hypotheses:

H6: The higher the relevance of trademarks as protection strategies, the higher the likelihood to patent:

- in order to increase the company value,
- in order to increase the technological image of the company,
- in order to improve the position of the own company relating to cooperation partners, in licensing negotiations and in the capital market.

We use the following parameters coded as dummy variables, with the exception of the R&D intensity, as explanatory variables in our regression model.

Table 5
Description and means of further explanatory variables

The dependent variables in the Probit models are specified as 1 if the motive to patent is assessed to be high or very high and 0 in case of very low, low or medium assessment. The means of the dependent variables are displayed in Fig. 3. In addition to the variables above, we include the logarithms of the company size measured by the number of employees and the sector as dummy variables, with the mechanical engineering sector as base category. The literature survey and the descriptive statistics displayed in Fig. 5 indicate that company size is not necessarily correlated linearly with the importance of the various motives to patent. Regarding the protection and the blocking motives, we postulate that these motives become more important with company size, but that very large companies have such strong market power, which makes patents as protection and blocking means less important than for medium-sized companies. Patents as an instrument to increase the reputation of a company is especially important for small companies, which leads to the hypothesis of a negative relationship between company size and the importance

of this motive. The exchange motive is obviously very important for small companies in order to get access to the capital markets, but also for very large companies to generate licensing revenues and to improve their position in negotiations. Therefore, we have to assume an inverse U-shape regarding the exchange motive. Finally, the incentive motive becomes obviously more important with company size. In order to allow also for non-linear relationships, we have included the square of the logarithms of the size variable. However, we report the results of the following five Probit models, which achieve the highest explanatory power:

$$\begin{aligned}\text{Protection}_{ij} = {} & a_0 + a_1\text{ComInt}_{ij} + a_2\text{CoopInt}_{ij} + a_3\text{R\&DInt}_{ij} + a_4\text{CopatInt}_{ij} + a_5\text{PatSearchInt}_{ij} \\ & + a_6\text{Marketing}_{ij} + a_7\text{CompanySize}_{ij} + a_8(\text{CompanySize})^2_{ij} + a_9\text{Sector}_j + \varepsilon_{ij} \end{aligned} \quad (1)$$

$$\begin{aligned}\text{Blockade}_{ij} = {} & a_0 + a_1\text{ComInt}_{ij} + a_2\text{CoopInt}_{ij} + a_3\text{R\&DInt}_{ij} + a_4\text{CopatInt}_{ij} + a_5\text{PatSearchInt}_{ij} \\ & + a_6\text{Marketing}_{ij} + a_7\text{CompanySize}_{ij} + a_8(\text{CompanySize})^2_{ij} + a_9\text{Sector}_j + \varepsilon_{ij} \end{aligned} \quad (2)$$

$$\begin{aligned}\text{Reputation}_{ij} = {} & a_0 + a_1\text{ComInt}_{ij} + a_2\text{CoopInt}_{ij} + a_3\text{R\&DInt}_{ij} + a_4\text{CopatInt}_{ij} + a_5\text{PatSearchInt}_{ij} \\ & + a_6\text{Marketing}_{ij} + a_7\text{CompanySize}_{ij} + a_9\text{Sector}_j + \varepsilon_{ij} \end{aligned} \quad (3)$$

$$\begin{aligned}\text{Exchange}_{ij} = {} & a_0 + a_1\text{ComInt}_{ij} + a_2\text{CoopInt}_{ij} + a_3\text{R\&DInt}_{ij} + a_4\text{CopatInt}_{ij} + a_5\text{PatSearchInt}_{ij} \\ & + a_6\text{Marketing}_{ij} + a_7\text{CompanySize}_{ij} + a_9\text{Sector}_j + \varepsilon_{ij} \end{aligned} \quad (4)$$

$$\begin{aligned}\text{Incentive}_{ij} = {} & a_0 + a_1\text{ComInt}_{ij} + a_2\text{CoopInt}_{ij} + a_3\text{R\&DInt}_{ij} + a_4\text{CopatInt}_{ij} + a_5\text{PatSearchInt}_{ij} \\ & + a_6\text{Marketing}_{ij} + a_7\text{CompanySize}_{ij} + a_9\text{Sector}_j + \varepsilon_{ij} \end{aligned} \quad (5)$$

The results of the Probit estimations are presented in Table 6. The five models are able to explain the likelihood of using patents for the various motives to a different degree. The models explaining the importance of the incentive and exchange motives have the highest fit, the fit of the models explaining the traditional protection and blocking motives is lower, whereas the fit of the reputation model is lowest, which indicates the lack of further important explanatory variables. However, the results of the five models allow a valid assessment of the six hypotheses presented above, as well as a final discussion of sector and company size influences.

Table 6
Results of Probit estimations

First, the perceived competition intensity of the companies is a very important influencing factor for the models explaining the importance of the traditional protection and blocking motives, whereas it has no significant influence on the three more strategic motives to patent.

Second, the frequency of cooperation with various types of partners is only significant for explaining the importance of the exchange motive, which just postulates that patents are an important bargaining chip in cooperations, especially with other companies.

Third, the R&D intensity is obviously no significant factor for explaining the importance of the traditional motives to patent, like protection from imitation and blocking of competitors. However, the R&D intensity is able to explain positively the likelihood, not only to patent in order to increase the exchange potential of the own company, e.g. in licensing negotiations, or to get access to the capital market, but also to use patents as incentives for their employees or as performance indicators. More R&D-intensive companies tend – in comparison to less R&D-intensive companies – to patent especially to use them as bargaining chips with other actors, like companies or cooperation partners, and to use patents as incentives for their R&D employees, but also as internal and external performance indicators. However, in

contrast to our expectation they have no stronger need to patent in order to protect their knowledge from imitation or to secure their technological flexibility.

Fourth, companies already active in co-patenting are obviously very sensitive regarding the traditional, but also the new strategic value of patents and see consequently a higher importance to patent in order to protect their knowledge base from imitation, to block competitors, but also to increase their reputation and to increase their position in relation to other stakeholders.

Fifth, the frequency of patent searches in order receive information about the state-of-the-art in technology has, surprisingly, no influence on the importance of the traditional motives to patent, although one might expect that this experience increases the sensitivity to secure the own technology flexibility against the patent claims of competitors. In contrast, the experience with patent searches strengthens the understanding of the possibility to use patents in order to improve the value and technological image of the own company, but also to improve its position in negotiations. Finally, in-depth knowledge in patent databases improves also the overview of the patent performance of competitors, which is obviously a good precondition to use patents especially as performance indicator for single employees or R&D departments internally, but also for the comparison of the performance of the own company in relation to competitors.

Sixth, a high importance of using trademarks as a protection strategy also has impacts on the motives to patent. On the one hand, emphasising trademark protection has a positive influence on the likelihood to attribute a high or very high importance to the protection motive. There is obviously a synergy of protection motives. On the other hand, the focus on trademark protection has a positive effect on using patents also as an instrument to increase the reputation of the own company. Like trademarks patents become also an instrument for the marketing activities of a company.

Summarising the results of the Probit analyses and comparing them with the six hypotheses outlined above reveal that the majority of the hypotheses can be confirmed. However, some hypotheses regarding the explanation of the traditional protection and blocking motives cannot be confirmed, especially like the missing link to R&D intensity and to the frequency of patent searches. These aspects are much more closely linked to the strategic motives to patent.

Regarding the influence of the company size on the importance of the various motives to patent, the Probit analyses reveal some new insights. First, we find no significant influence of the company size on the assessment of the importance of the protection and blocking motives. However, there is a weak indication that with increasing company size the protection and blocking motives becomes more important, but for very large companies these motives are less important because of their general market power. The company size has the expected negative, but not significant coefficient in the estimation of the reputation model. Finally, the importance of the exchange and the incentive motive is significantly correlated with company size, which contradicts the structure in Fig. 5 in case of the exchange motive. Obviously, other factors like sector effects may be responsible for this.

In the last section, we discuss the sector differences detected in the Probit models. In order to be comprehensive, we have also identified the significant bilateral sector differences in addition to the significant gaps to the base sector mechanical engineering presented in Table 6. Table 7 reveals that significant sector differences hardly exist, especially if we take into account that there are 21 relations between the seven sectors. However, we find an interesting pattern of differences. On the one hand, in the regression model of the traditional motive protection just one significant difference can be observed between consumer goods and the mechanical engineering sector. This consistency has already been observed by Cohen et al. (2000) in the United States. On the other hand, there is only one significant bilateral sector difference in the model explaining the incentive and performance motive. This is different to the results observed by Cohen et al., who report in general a low importance of this motive and large sector differences. There is obviously a converging trend among sectors regarding the use of patents to motivate employees and to measure performance. The reputation motive differs also only between automotive sector, which puts a very high emphasis on patents as instrument to increase company reputation, and the consumer good, respectively chemical sector. In Cohen et al. (2000) there are numerous sector differences,

which indicate that there is a general trend among sectors to perceive patents as instruments to enhance company reputation. Furthermore, we observe five significant differences in the blocking motive, which are caused by the rather low assessment of this motive in the construction sector, which contradicts the results of Cohen et al. (2000), who find that "discrete" technologies, like the construction and paper industry, attribute a higher importance to the blocking motive. Finally, we find six significant bilateral differences in the exchange motive, which can be explained by the rather low importance of this motive in the mechanical engineering and the automotive sectors and the rather high assessment in the construction, chemical and electrical engineering sectors. Especially in the latter, cross-licensing is very important, whereas the biotechnology companies within the chemical sector emphasise the importance of patents to get access to the capital market, two motives of less relevance for the mechanical engineering and the automotive sector. The sector differences, we observe in the exchange motive, confirm that the distinction in "discrete" and "complex" industries is blurred because of the increasing "complexity" in all sectors.

If we summarise the company size and sector related discussion, we find interesting patterns. First, for large companies the strategic exchange and incentive motives are very important, whereas the traditional motives among the very large companies attract a slightly less attention. Sector differences can only be observed selectively in the blocking motives and the exchange motives, which can be explained by sector-specific characteristics. Finally, there is obviously a sector convergence both in the traditional protection motives and the strategic reputation and incentive motive, taking the results of Cohen et al. (2000) into account.

Table 7
Significant differences between sectors explaining patenting motives

5. Conclusions and Policy Implications

The main new insights of our research on motives to patent are the following three issues. First, the importance of the strategic motives to patent are confirmed, like the use of patents to improve the reputation of the company, its position in negotiations with other companies and to create incentives for its R&D employees or to measure their performance. Second, the clear distinction between "discrete" and "complex" industries by Cohen et al. (2000) cannot be observed any more in the structure of the patent motives. There is obviously a tendency of all industries towards "complex" products, which is also reflected in the motives to patent. Third, large companies especially emphasise strongly the new strategic motives to patent, like the improvement of its exchange potential and the use of patents as incentives and performance measures of their R&D personnel.

These observations have some severe policy implications. Since we observe a general strong tendency towards "complex" industries with the accompanying trend of patenting in order to build up large patent portfolios, the cost of innovation is likely to increase, not only in the former "complex" industries identified by Cohen et al. (2000), but in the whole economy. Consequently, these extensive patent portfolios are threatening the entry of new companies into the respective markets, which is also confirmed by the high emphasis of the small companies on the exchange motive. Furthermore, the intrinsic motivation of large companies to use patents for setting up internal incentive schemes or for measuring performance creates another driving force for their extensive patenting.

Taking these tendencies and their consequences together, small and medium-sized companies are further disadvantaged in comparison to large companies regarding patenting. They experience not only disadvantages on the cost side due to the relative higher fixed cost they have to bear, but large companies are privileged also on the benefit side In order to prevent further concentration processes, especially small- and medium-sized companies should be supported in using patents actively as protection and strategic instruments, but also in dealing efficiently with the patent claims of other companies. Furthermore, the quality of the patent system has to be improved in order to secure a high innovative level of granted pat-

ents. The more rigorous implementation will reduce the misuse of the patent system by the strategic motivations of large companies.

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Annex

Table A1
Differences between sectors in the importance of patenting motives

Sector 1 vs. Sector 2	Protection	Blockade	Reputation	Exchange	Incentive
Construction, mining vs. consumer goods	+	+	+	–	–
Construction, mining vs. chemical engineering	+	+	+	+	+
Construction, mining vs. metal production	+	+**	+	–	–
Construction, mining vs. mechanical engineering	+	+***	–	–	–
Construction, mining vs. automotive engineering	+	+**	+	+	+
Construction, mining vs. electrical engineering	+	+*	+	+	+
Consumer goods vs. chemical engineering	+	+	+	+	+
Consumer goods vs. metal production	+	+	+	–	–
Consumer goods vs. mechanical engineering	+	+	–	–	+
Consumer goods vs. automotive engineering	+	+	+	+	+
Consumer goods vs. electrical engineering	+	+	+	+	+
Chemical engineering vs. metal production	–	+	+	–**	–
Chemical engineering vs. mechanical engineering	+	+	–	–	–
Chemical engineering vs. automotive engineering	–	+	+	–	+
Chemical engineering vs. electrical engineering	+	+	+	–	+
Metal production vs. mechanical engineering	+	–	–	–	+
Metal production vs. automotive engineering	–	–	+	+	+
Metal production vs. electrical engineering	+	–	–	+	+
Mechanical engineering vs. automotive engineering	–	+	+	+	+
Mechanical engineering vs. electrical engineering	–	–	+	+	+
Automotive engineering vs. electrical engineering	+	–	–	–	+

The table reads as follows:
+ means that the share of respondents of the sector 2 giving the bundle of motives is higher than sector 1.
* mean a level of significance less 0.1,
** less than 0.05,
*** less than 0.01.

Table A2
Differences between company sizes in the importance of patenting motives

Company size 1 vs. company size 2	Protection	Blockade	Reputation	Exchange	Incentive
1–249 vs. 250–1999	–	+	–**	–**	+
1–249 vs. 2000 and more	+	+	–**	–	+**
250–1999 vs. 2000 and more	+	+	+	–*	+

The table reads as follows:
+ means that the share of respondents of the sector 2 giving the bundle of motives is higher than sector 1.
* mean a level of significance less 0.1,
** less than 0.05,
*** less than 0.01.

Table 1
Ranking of the significance of motives to patent in recent empirical studies*

	Arundel et al. 1995 (1993)	Duguet and Kabla 1998 (1993)	Cohen et al. 2002 (1994)	Pitkethley 2001 (1994)[10]	Ifo 1999 (1997)	OECD 2003 (2003)**[11]
Protection from imitation (traditional motive)	1	1	1	1	1	–
Strategic motives						
Defensive blockade	3	2	3	–	2	3[12]
Offensive blockade	–	–	2	2	3	–
Reputation/technical image	–	–	5	–	6	–
International market extension	5	5		–	–	4
Internal performance indicator/ motivation	6	6	7	–	5	–
Exchange potential/ negotiating mass	2	2	4	3	4	2
Licensing revenues	4	4	6	4	7	5
Make own invention the standard	–	–	–	5	–	–
Capital market	–	–	–	–	–	6
Forced to patent because of patent practice of others	–	–	–	–	–	1

Source: own compilation.
* in brackets the actual year during which data were collected (field phase).
** the OECD study asked about changes in the significance in the last ten years.

Table 2
Sector and size distribution of the sample

Sectors (NACE codes in brackets)	Size classes			
	1–249	250–1999	2000 and more	Total
Construction (10–14)	9	20	15	44
Consumer (15–19, 36)	9	5	6	20
Chemistry (incl. bio/pharma) (24)	54	36	28	118
Metal production (27)	18	17	11	46
Mechanical engineering (29)	35	55	26	116
Motor vehicles (34)	13	23	31	67
Electrical engineering (30–33)	36	49	26	111
Total	174	205	143	522

[10] In the illustration of the results of the Pitkethly study, only those motives were considered which referred to the application for own patents. Therefore the motives “market leadership”, “licensing in”, “information source” were left out of the overview.

[11] The OECD survey asks about changes in very many different influential factors in the last ten years. Only the ones were selected and ranked which can be classified as strategic reasons. Left out were for example competitive intensity and factors which present a simplification within the system (enforceability of patents etc.). The sequence was determined by means of OECD graphics and is oriented towards the share of enterprises which classified the motive as very important.

[12] The enterprises were asked whether the number of patent applications to protect an individual invention increased. This corresponds in the impacts to the defensive blockade defined above.

Table 3
Importance of protection instruments (share of companies giving high or very high importance)

	Importance
Lead time advantage	0.88
Patent strategies abroad	0.79
Domestic patent strategies	0.72
Exclusive relations to customers	0.66
Trademarks	0.58
Secrecy	0.58
Supplier contracts	0.51
Long-term contracts with workforce	0.44
Utility patent	0.24
Copyright	0.15
Design patent	0.11

Table 4
Importance of motives to patent (share of companies giving high or very high importance)

	Importance
Protection from imitation	0.84
Securing European markets	0.75
Defensive blockade of competitors	0.72
Securing national markets	0.71
Improvement of technological image	0.69
Offensive blockade of competitors	0.69
Securing markets outside Europe	0.57
Increase of company value	0.51
Improvement of position in cooperation	0.39
Incentives for employees	0.32
Assets for exchange (i.e. cross licensing)	0.28
Access to the capital market	0.26
Internal performance indicator	0.22
Generation of revenues from licences	0.21
Influence on standardisation	0.20

Table 5
Description and means of further explanatory variables

Variable (acronym)	Description	Means (standard deviation)
Competition intensity (CompInt)	Value 1: high or very high competition intensity in at least the national, European or international market	0.92 (0.28)
Cooperation intensity (CoopInt)	Value 1: frequent cooperation at least with suppliers, customers, competitors, private R&D service providers or public research institutes	0.58 (0.49)
R&D intensity (R&DInt)	% of R&D personnel of total personnel	0.16 (0.23)
Co-patenting intensity (CopatInt)	Value 1: frequent use of co-patents[13]	0.06 (0.23)
Patent search intensity (PatSearchInt)	Value 1: frequent or regular searches in patent databases in order to achieve information about the state-of-the-art in technology[14]	0.72 (0.45)
Marketing dummy (Marketing)	Value 1: high or very high importance of trademarks as protection instrument	0.61 (049)

[13] We assume that applying for patents together with other companies is an exogenous factor, because co-patenting is driven by technological requirements and not by strategic motives.

[14] There are also other motives to perform patent searches, like looking for cooperation partners. These motives are not exogenous factors influencing the importance of patenting motives. Therefore, we restrict ourselves in this specific motive to performing searches in patent databases.

Table 6
Results of Probit estimations

Motive	Protection		Blockade		Reputation		Exchange		Incentive	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Competition intensity	0.84***	0.29	0.74***	0.25	0.20	0.25	–0.08	0.26	0.32	0.24
Cooperation intensity	0.05	0.21	0.22	0.16	–0.07	0.14	0.30**	0.13	–0.08	0.13
R&D intensity	0.03	0.39	–0.33	0.41	0.46	0.32	2.19***	0.44	0.84***	0.31
Co-patenting intensity	0.86*	0.45	0.90**	0.40	0.70*	0.41	0.74**	0.30	0.16	0.28
Patent search intensity	–0.08	0.22	0.15	0.17	0.36**	0.15	0.62***	0.14	0.45***	0.14
Marketing dummy	0.52***	0.19	0.09	0.16	0.33**	0.14	0.15	0.13	0.16	0.13
Company size	0.24	0.21	0.19	0.19	–0.05	0.04	0.09**	0.04	0.13***	0.04
(Company size)^2	–0.02	0.02	–0.01	0.01	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Construction	–0.45	0.38	–0.77***	0.29	–0.03	0.25	0.63**	0.25	–0.02	0.24
Consumer goods	–0.91*	0.51	–0.45	0.46	–0.33	0.38	0.11	0.37	0.14	0.36
Chemical engineering	–0.38	0.34	–0.43*	0.25	–0.12	0.20	0.54***	0.19	–0.01	0.19
Metal production	–0.58	0.40	–0.10	0.35	0.06	0.27	0.16	0.24	–0.29	0.25
Automotive engineering	–0.54	0.37	–0.21	0.30	0.38	0.27	–0.08	0.24	–0.09	0.23
Electrical engineering	–0.15	0.33	–0.26	0.25	0.11	0.20	0.33*	0.18	0.22	0.18
Constant	0.33	0.75	0.02	0.68	0.36	0.37	–1.65***	0.37	–1.97***	0.34
Pseudo R^2	0.1139		0.0923		0.0467		0.1414		0.1510	
Number of observations	465		465		465		465		465	

Table 7
Significant differences between sectors explaining patenting motives

Protection	Blockade	Reputation	Exchange	Incentive
consumer goods < mechanical engineering	construction < metal production	consumer goods < automotive engineering	construction > mechanical engineering	chemical engineering < electrical engineering
	construction < mechanical engineering	chemical engineering < automotive engineering	chemical engineering > mechanical engineering	
	construction < automotive engineering		electrical engineering > mechanical engineering	
	construction < electrical engineering		construction > automotive engineering	
	chemical engineering < mechanical engineering		chemical engineering > automotive engineering	
			electrical engineering > automotive engineering	

The sign < means that the share of companies in the first sector attributing a high or very high relevance to the patenting motive is significantly less than the respective share of the second sector.

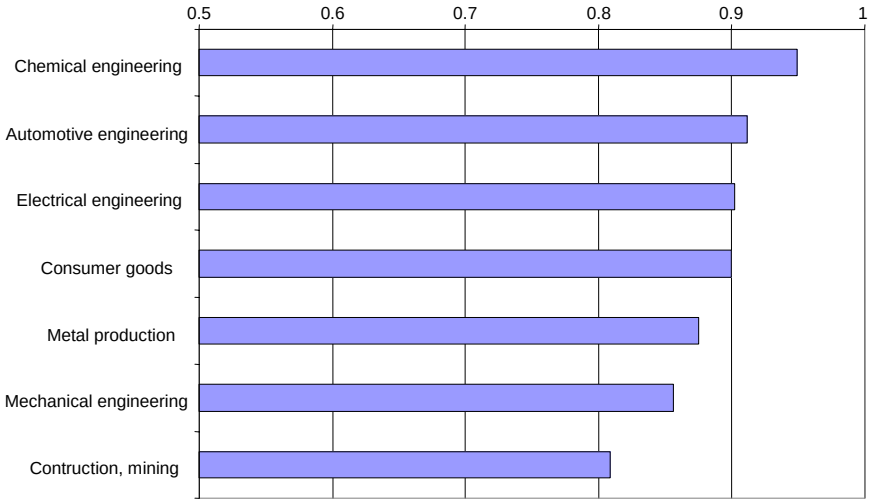

Fig. 1. Importance of patenting as protection strategy differentiated by sector
(share of companies giving high or very high importance)

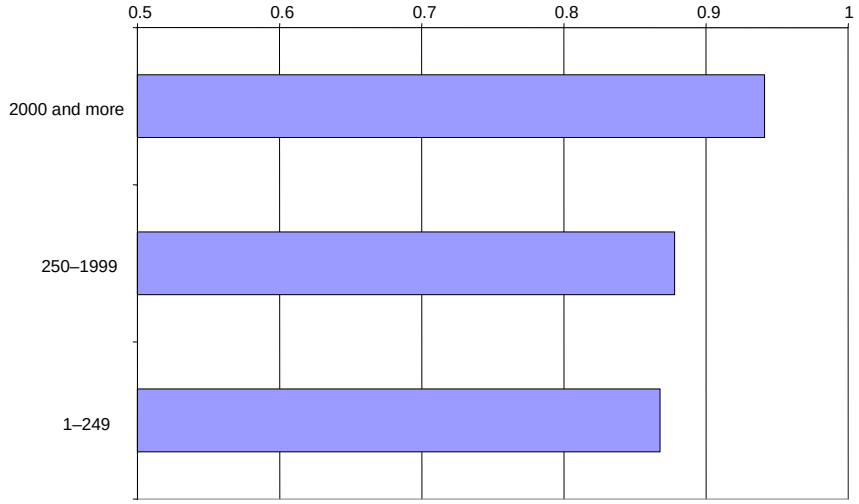

Fig. 2. Importance of patenting as protection strategy differentiated to company (number of employees)
(share of companies giving high or very high importance)

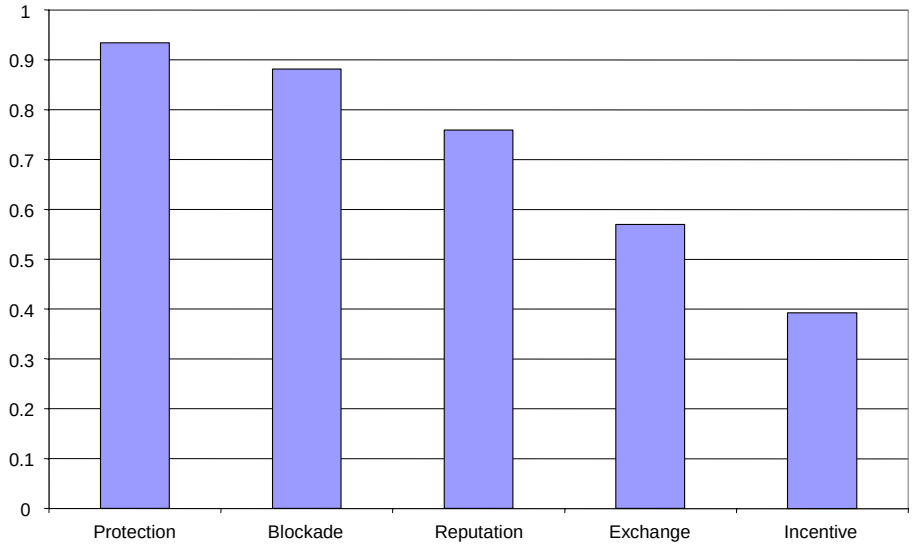

Fig. 3. Importance of clustered patenting motives (share of companies giving high or very high importance)

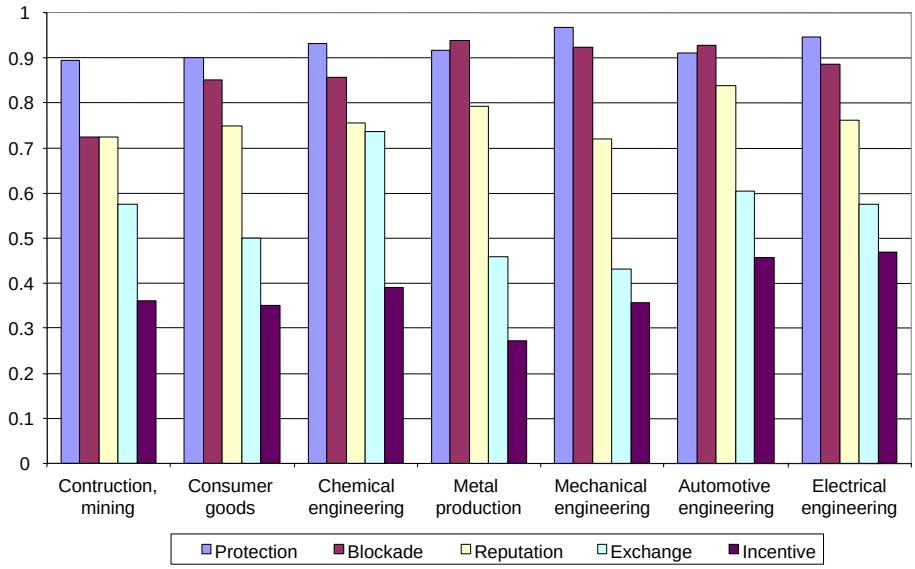

Fig. 4. Share of companies giving a high or very high importance to the grouped patenting motives differentiated by sector

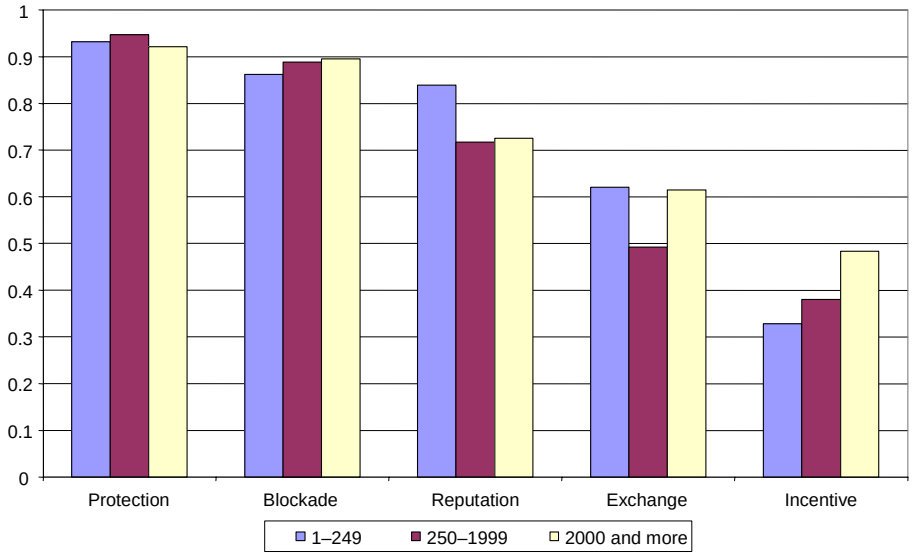

Fig. 5. Share of companies giving a high or very high importance to the grouped patenting motives differentiated by company size