Research Policy 42 (2013) 35–49

Contents lists available at SciVerse ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

To protect or not to protect? Modes of appropriability in the small enterprise sector

Jörg Thomä [a,*], Kilian Bizer [a,b]

[a] ifh Göttingen, Institute of Small Business Economics at University of Göttingen, Heinrich-Düker-Weg 6, 37073 Göttingen, Germany
[b] Chair of Economic Policy and SME Research, University of Göttingen, Platz der Göttinger Sieben 3, 37073 Göttingen, Germany

ARTICLE INFO

Article history:
Received 31 August 2010
Received in revised form 21 April 2012
Accepted 28 April 2012
Available online 24 May 2012

Keywords:
Appropriability
Innovation protection mechanisms
Intellectual property rights
SMEs

ABSTRACT

What appropriation strategies are chosen by innovative small firms? A cluster analysis of data from the German CIS was carried out to indentify four distinct modes of appropriability in the small enterprise sector. The results show that for many innovative small firms the key question is not whether to use intellectual property rights (IPRs) or not, but whether to protect their innovations from imitation at all. Furthermore, formal and informal innovation protection mechanisms should not be seen as mutually exclusive, since several are employed jointly. Secrecy and lead time advantages over competitors are often combined with IPRs. Yet, a number of small firms use complexity of design as a substitute to patent protection. The relevance of each appropriation mode depends on such factors as the degree of innovativeness, the type of innovator and the general market environment, which implies that the importance of IPRs is limited to specific business contexts. Furthermore, regarding firm performance as measured by innovation effects, some evidence is found that choosing both IPR- and non-IPR-oriented appropriation strategies can prove to be effective in achieving company goals. Taken all together, the study implies that the use of IPRs by innovative small firms is highly selective. The paper concludes with a discussion of the implications for policy and research.

1. Introduction

The varying ability of innovators to protect themselves from imitation and to appropriate an adequate proportion of innovation returns is regarded as an important driver of diversity in innovation activities both at the firm and the sector level (Levin et al., 1985; Pavitt, 1984; Teece, 1986).

Intellectual Property Rights (IPRs), especially patents, play a major role in this discussion. In theory, IPRs are an effective mechanism for resolving the appropriability problem of knowledge. Indeed, the standard justification for granting IPRs is that they induce incentives to produce socially desirable innovations, thereby mitigating the effects of innovation market failure (Granstrand, 1999; Greenhalgh and Rogers, 2007; Guellec and Van Pottelsberghe de la Potterie, 2007). Based on this assumption, the fostering of IPR usage by small and medium enterprises (SMEs) is regarded as an integral part of innovation policy. Despite their widely recognized importance for innovations, smaller firms often refrain from using registered IPRs. One explanation may be that SMEs are disadvantaged by their smaller company size when it comes to the awareness, acquisition and enforcement of IPRs (Cohen et al., 2000; Hall et al., 2003; Lanjouw and Schankerman, 2004; Macdonald, 2004; Rothwell, 1983). Thus, to attenuate these potential impediments to innovation the strengthening of IPR usage by SMEs is regarded as a major task for policy makers (European Commission, 2006; PRO INNO Europe, 2007; Radauer et al., 2007; WIPO, 2003).

However, according to Jensen and Webster (2006) this must not be the end of the story. They argue that policy makers should first take into account the general appropriability conditions that small firms face before focusing on their ability to utilize IPRs. Similarly, albeit more generally, Scotchmer (2004) points out that it is always better to start from the appropriability problem itself rather than assume at the outset that IPRs are the best solution. Hence, two aspects take on special interest.

Firstly, the prevalence of innovation market failure in sectors or industries has to be assessed. In the present context this depends to a large degree on the inherent replicability of technology and the subsequent ease of imitation by competitors. At one extreme there is market failure because the relevant knowledge base is fully codifiable, leaving the marginal costs of imitation at zero. In this instance one would expect a strong positive link between IPR protection and innovation incentives. At the other extreme the critical knowledge base is highly tacit in nature. Apart from the hiring away of key employees, imitation by competitors may now be impossible. Lack of innovation incentives owing to low appropriability

* Corresponding author. Tel.: +49 551 39 174886; fax: +49 551 39 174893.
E-mail address: joerg.thomae@wiwi.uni-goettingen.de (J. Thomä).

0048-7333/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.respol.2012.04.019

should therefore be less of a problem, since a high degree of knowledge tacitness serves in itself as a strong protection mechanism (Dosi et al., 2006; Hurmelinna-Laukkanen and Puumalainen, 2007; Jensen and Webster, 2006; Teece, 2002, 2003). Indeed, much of the operating knowledge in small firms tends to be tacit. Tacitness therefore works as an effective appropriation method, in particular for small firms (Nooteboom, 1994). Moreover, patents may not be available to a great number of small firms precisely because their tacit knowledge base cannot be reduced to codified information.

Secondly, even in the case of potential market failure a low level of IPR usage does not give rise to public concern when effective remedies are available. A number of studies have shown the relative unimportance of IPRs as a means of profiting from innovation. Other appropriation methods such as lead time, secrecy or complementary assets are deemed in most industries to be more effective than patents (e.g. Cohen et al., 2000; Harabi, 1995; König and Licht, 1995; Laursen and Salter, 2005; Levin et al., 1987; Mansfield, 1986).[1] Some of these studies also discuss the impact of firm size on the perceived effectiveness of IPR protection. Broadly speaking, they come to the conclusion that smaller firms are less likely to make use of IPRs because of cost and complexity issues, and instead probably rely on informal methods such as secrecy (e.g. Arundel, 2001; González-Álvarez and Nieto-Antolín, 2007; Hanel, 2008; Sattler, 2003).

Despite the economic significance of SMEs, however, very few studies explicitly address the general appropriability conditions of small firms and draw conclusions for innovation policy from their findings. Kitching and Blackburn (1998) examined this issue systematically for the first time (see also Kitching and Blackburn, 2003). From a telephone survey of small firms in the UK (four sectors: computer software, design, electronics, mechanical engineering) and subsequent face-to-face interviews, the authors showed that most SME owner-managers preferred informal protection practices (e.g. creating high-trust relations with customers and suppliers, maintaining a lead time advantage over competitors or operating in small niche markets) because they found them more familiar, cheaper, less time-consuming and more effective than IPRs. Furthermore, owner-managers saw these practices as vital to the commercialization of innovations and hence as a key component of their broader competitive strategy. Thus, the majority of small business owners did not consider access to or the use of IPRs as an impediment to the successful appropriation of innovation returns. Indeed, most owner managers were largely indifferent to the IPR system, since they felt that it neither facilitated nor hindered their innovative efforts. On the other hand, the use of IPRs was only reported under extremely selective conditions. SME owner-managers preferred IPRs in situations where the potential benefits were perceived to outweigh any potential acquisition or enforcement costs. Anticipation of a high degree of commercial innovation success, an appraisal of IPRs as more effective than informal methods and the possession of the necessary resources to acquire formal protection constituted the prerequisites here. From their results, Kitching and Blackburn (1998, 2003) conclude that policy attempts to remove barriers to IPR usage may have little impact on innovation by SMEs. In their view, instead of focusing on the protection of existing innovations through easier access to IPRs, policy makers should promote the introduction of new innovations in SMEs.

The study by Leiponen and Byma (2009) also has an explicit focus on small firms. According to these authors, the appropriation strategies pursued by small firms differ qualitatively from those of larger firms. In a survey of knowledge-intensive Finnish SMEs in the manufacturing and service industries, it is again shown that a great number of small firms prefer informal protection practices to IPRs. Only highly R&D-intensive small firms and those that cooperate with universities in R&D saw patents as the most important protection instrument. Indeed, it becomes evident that innovation-related cooperation activities in general have a major impact on the kind of appropriation strategies chosen by SMEs. Furthermore, the majority of small firms did not consider secrecy to be the most important protection mechanism. Instead they tended for the most part to benefit from a speed to market strategy in their efforts to achieve a lead time advantage over competitors. From their results, Leiponen and Byma (2009) argue that small firms may be disadvantaged by their size in the use of IPRs, and suggest a critical re-evaluation of current patent-focused IPR policies. Moreover, they discuss several proposals on how the IPR system might provide more support for SMEs.

Using a large sample size, the aim of our paper is to corroborate existing empirical evidence and to deepen the understanding of appropriation strategies taken by innovative small firms. Several issues deserve further investigation. *Firstly*, SMEs should not be treated as a single entity. Instead, the strong skewness in firm size distribution toward smaller enterprises requires consideration with regard to the great diversity among small firms. In this way policy makers will be in a better position to meet the specific needs of certain SMEs (Curran and Blackburn, 2001). Taxonomies of innovation are a common method of accounting for such heterogeneity at the firm or sector level (Evangelista, 2000; Hollenstein, 2003; Jensen et al., 2007; Pavitt, 1984). As de Jong and Marsili (2006) have indicated, the taxonomic approach is particularly beneficial when studying the variability of innovative small firms. Yet, they did not focus on appropriation strategies in their identification and profiling of distinct clusters of small firms. We therefore seek to determine and characterize different modes of appropriability in the small enterprise sector. In this way, we will not have to treat the different innovation protection mechanisms under review as separate choices or even as mutually exclusive, as is the case in most studies on this topic (for an exception, see Amara et al., 2008). An examination of their interplay seems especially promising, since the strength of individual appropriation methods often lies in their combined use (Bosworth and Webster, 2006). As a further advantage we can interpret the use of IPRs by small firms within the context of their overall appropriation strategy. In so doing, policy makers may arrive at a better understanding of the general importance of patents in the ability of small firms to profit from innovation (Arundel, 2000).

Secondly, as the above discussion suggests, it might be argued that the less frequent SME usage of IPRs not only results from size-related disadvantages inherent in the IPR system but also reflects specific features of innovation protection practices in small firms. In fact, it is worth noting that small firms are not merely a scaled-down version of large firms (Penrose, 1959). Since the former are less likely to introduce R&D-intensive innovations that are fundamentally new, the novelty of their innovations is frequently determined differently from that of large firms. Because of behavioral advantages in terms of flexibility and speed of response, innovation in smaller firms is often associated with a better differentiation of existing products by focusing on superior customer service or by the fast, flexible and incremental adjustment of product quality to customer needs (Appiah-Adu and Singh, 1998; Baldwin and Gellatly, 2003; Mazzarol and Reboud, 2009; Wynarczyk et al., 1993). As a result, for example, in consideration of the framework of Teece (1986), complementary assets such as sales, services or manufacturing capabilities may in many cases be of greater importance in the successful commercialization of small firm innovation than the protection of core technological know-how via IPRs. Thus, to determine whether the lower use of IPRs by SMEs might also be related

[1] See López (2009) for a comprehensive literature review on this topic.

to such factors, this paper aims to interpret the appropriation strategies of innovative small firms in the light of their specific business contexts.

Thirdly, evidence from Kitching and Blackburn (1998, 2003) suggests that small business owners use informal methods not only to protect their innovations but also to commercialize them. Thus, two key conditions regarding the appropriability of innovations were reported.[2] Preventing imitation through strong protection is one important condition for an effective appropriation strategy. Nevertheless, a second, albeit crucial, condition consists in the degree to which protection methods are likely to increase innovation returns and enable innovators to garner sufficient profit from their innovations (Hurmelinna-Laukkanen, 2009; Jantunen and Hurmelinna-Laukkanen, 2006; Teece, 1986, 2006). Studies of appropriability frequently focus on the first condition, implicitly assuming that the second condition has been met. However, a comparison of different appropriation strategies to assess the relevance of IPRs for innovative small firms also calls for consideration of their importance with regard to company goals. Moreover, in this way more insight can be derived into which kinds of innovation are protected by which types of protection mechanism. A further purpose of our paper is therefore to give some indication of the relationship between firm performance as measured by several innovation effects and distinct modes of appropriability in the small enterprise sector.

The rest of the paper is structured as follows: Section 2 describes the data set and the variables used. In Section 3, factor analysis and cluster analysis are combined to identify different modes of appropriability in the small enterprise sector. Assuming that this taxonomy represents different types of appropriation strategy chosen by innovative small firms, Section 4 assesses the predictive validity of the derived cluster solution and describes its characteristics in relevant business dimensions. Section 5 provides some concluding remarks and discusses the implications for policy and research.

2. Data set and variables

Our empirical analysis rests on data from the German Innovation Survey ("Mannheim Innovation Panel"), which is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry of Education and Research. Based on a broad set of questions covering all fields of innovation, this survey offers detailed information on the innovation activities of firms in the manufacturing and service sectors. To carry out the analysis we used anonymised data from the survey wave of 2005. In that year the survey constituted the German part of the fourth EU-wide Community Innovation Survey (CIS IV) covering the three-year reference period 2002–2004. While the German Innovation Survey corresponds fully with the harmonized CIS questionnaire with regard to content and methodology, it has distinct advantages over the CIS. First of all, data is available on a wider selection of questions, allowing the relationship between the innovation activities of firms, their market environments and their economic performance to be analyzed in more depth. In the present case, for example, we have information not only on the use of IPR protection and other informal methods such as secrecy or lead time advantage as measured on a binary scale (i.e. 'yes' or 'no'), but also on their degree of importance on an ordinal scale. Furthermore, compared with the CIS, the German Innovation Survey has a somewhat broader sector and size coverage. It also includes firms with between 5 and 9 employees and has a larger set of service sectors. Both aspects are especially beneficial to our subject of investigation (see Janz et al., 2001 and Rammer et al., 2009 for a general discussion of the German Innovation Survey).

The population of the 2005 survey wave was drawn as a stratified random sample. The variables used for stratification were industry classification (mainly at the 2-digit sectoral level), firm size (7 to 8 size classes, depending on the industry sector) and region (East or West Germany). The gross sample, corrected for neutral losses (owing to firm closure, mergers etc.), comprised a total of 27,926 firms, 5476 of which returned a questionnaire. This represents a response rate of 20%. A stratified random sample was drawn from the group of non-responding firms to check for a potential bias resulting from unit non-response. About 19% of non-respondents were contacted in a telephone survey to answer several core innovation-related questions (Aschhoff et al., 2007).

Since we are interested in the roles of different protection mechanisms in innovative small firms, we restricted our data set in two ways. Firstly, the analysis was confined to the subsample of innovators. A company was classified as innovative if it had introduced product and/or process innovations during the reference period 2002–2004 or if it reported innovation projects not yet completed in this time frame. Secondly, for several reasons, we removed firms with more than 49 employees from the dataset. Given the strong skewness in company size distribution toward smaller firms, it could be argued that the heterogeneity of appropriation strategies – our interest – is likely to be highest among small-sized firms. Furthermore, since our study also aims to inform policy-making more effectively in this field, we decided to focus on one important subgroup of innovative SMEs. Finally, as Greenhalgh and Rogers (2007, p. 563) point out, existing empirical research on the potential disadvantages of smaller firms using IPRs "has generally neglected to include information about the smallest firms (i.e. those with fewer than 50 employees)". Accordingly, our sample contains data on 1624 innovative small firms which have between 5 and 49 employees.

In the first empirical part of the paper, we employ cluster analysis to examine whether innovative small firms form distinct groups with respect to their overall appropriation strategy (a detailed description of the methodological procedure and corresponding results are given in Section 3). The variables used for this purpose are based on a set of questions in which firms were asked if they had used certain innovation protection mechanisms during the reference period, that is, those of patent, utility model[3], industrial design, trademark, copyright, secrecy, complexity of design and lead time advantage. The first five of these constitute formal protection methods. They are granted as exclusive rights on intellectual property for a certain period of time. The final three comprise informal efforts by innovators to protect themselves against imitation. They either prevent unintended knowledge spillover to competitors (secrecy), increase the time and cost required for imitation (complexity of design) or lead to benefits gained from the rapid implementation of innovation projects (lead time advantage). Firms were further asked to assess the importance of the mechanisms used. Therefore, the relevance of an innovation protection method is measured on a 4-point Likert scale (0 = no utilization, 1 = low importance, 2 = moderate importance, 3 = high

[2] We apply the conventional definition as proposed, for example, by Malerba (2002, p. 252): "Appropriability of innovations summarizes the possibilities of protecting innovations from imitation and of reaping profits from innovative activities".

[3] The utility model was introduced as a "petty patent" in some countries (including Germany) to provide a cheaper but simpler alternative to patent protection. It is deemed particularly suited to the specific needs of SMEs. Utility models are available for less inventive steps (incremental improvements and adaptations of existing products), can be registered more quickly and are less expensive to acquire and maintain than patents. Compared with patents, however, they have a shorter protection term and provide less legal protection (Radauer et al., 2007; WIPO, 2004).

importance).[4] Since not all respondents provided full information on this set of questions, the number of observations available for statistical analysis in Section 3 was reduced to 1257.

Descriptive statistics on the primary variables are provided in Table 1. As expected, informal protection practices are, on average, more important for small firm innovators than IPRs. Lead time is most frequently considered to be of moderate or high importance, followed by secrecy and the complexity of design. However, for a certain number of respondents IPR protection is also of moderate or high importance (12.5% in the case of patents). Furthermore, it becomes evident that in each case a large number of innovative small firms refrained from using the corresponding mechanisms.

Descriptions of the variables used in the second part of the empirical analysis (see Section 4) for validating and profiling the derived appropriation modes are shown in Table A1 (see Appendix A). In order to assess the predictive validity of our cluster solution, we follow Hair et al. (1998) in selecting variables that are not used to form clusters but are expected to vary strongly across them. In the light of the discussion above, two variables should be key drivers of variability in the appropriation strategies of innovative small firms: the conducting of in-house R&D on a permanent basis and engagement in innovation-related cooperation activities. Furthermore, a third input-related variable reflecting different levels of innovation intensity (i.e. the total innovation expenditure as a share of turnover in %) is used for validation, since more expensive innovations should also require stronger protection efforts to recover these investments.

Next, to provide a better understanding of the choice of protection mechanisms made by innovative small firms, we use a set of variables to characterize each appropriation mode in three key dimensions. *Firstly*, we are able to use 22 industry dummies that primarily refer to the two-digit level of NACE Rev.1[5] to describe the industry composition of the clusters. Yet, to account for the fact that some industries are more likely to appreciate protection methods than others, we created a variable of industry groups according to their approximate degree of knowledge intensity (four categories: knowledge-intensive manufacturing, other manufacturing, knowledge-intensive services, and other services). For this purpose we used the NACE Rev.1 classification of knowledge-intensive industries in the case of Germany provided by Grupp et al. (2000). Since the degree of R&D intensity has drawbacks as an indicator of innovation in service sectors, the criteria used by these authors to assess the knowledge intensity of industries are given as above-average shares of engineering and natural science graduates, of R&D personnel and of general graduates (including graduates from non-technical sciences).

Secondly, we examine the possible influence of several output-oriented measures on the choice of appropriation strategy. To begin with, we examine the roles of basic types of innovators. The findings of Arvanitis and Hollenstein (1996) indicate that the use of both formal and informal protection methods may be more important for product innovators in general than for process innovators. In addition, the fact that smaller firms are less likely to carry out several innovation projects at the same time suggests that their use of innovation protection mechanisms should be more selective. To obtain further insights into this issue we consider four innovator groups: product-only innovators, process-only innovators, comprehensive innovators (small firms engaged in product and process innovations) and nascent innovators (small firms that report only innovation projects not yet completed during the reference period). Because process technology cannot easily be observed from the outside and contains a relatively high degree of knowledge tacitness (often a result of hands-on experience and intimate familiarity with the processes involved), it is expected to be less prone to reverse engineering by imitators than product technology (Gopalakrishnan et al., 1999; Nieto and Pérez-Cano, 2004; Teece, 2003). Thus, in the case of process innovations, either a lower overall need for active protection efforts or at least a greater importance of secrecy protection may be observed. Moreover, since comprehensive innovators are more innovative in the broad sense (Baldwin and Gellatly, 2003), we expect a general preference of protection methods by these small firms. With regard to nascent innovators, it would be interesting to know whether innovation protection on the whole is considered less relevant.

In addition, we argue that the need for innovation protection is positively correlated to the degree of innovation. We therefore distinguish different kinds of significant innovations by creating four binary variables, whereby the first two constitute product innovations and the last two process innovations (for the following see Rammer et al., 2009). On the one hand, new-to-market innovations comprise recently introduced products or services that have not yet been supplied to the respective market segments. This implies that they do not necessarily need to be world firsts as innovations, but may gain their innovative character from market boundaries such as a regional business focus or a concentration on specific customer groups. New-to-firm innovations are product innovations that have no predecessors in a firm's range of products or services. They may be new-to-market innovations at the same time or simply an imitation of a competitor's product. Both types of significant product innovation may result in more profitability through an increased market share or the charging of higher prices. To be successful in this sense, however, firms need to take inventive steps that are clearly visible to their customers. Thus, in the case of new-to-market innovations in particular, we expect a high importance of innovation protection efforts. On the other hand, efficiency innovations are new processes that improve the cost efficiency of production processes (e.g. through advanced automation, simplification of procedures or the realization of synergies) and may result in increased price competitiveness among the innovating firms. Quality innovations are new processes that increase the quality of products or services and may therefore also permit higher sales. They are particularly relevant in service industries and often demand more precise and sometimes more time-consuming and costly production processes. Comparing the two kinds of significant process innovation, we suspect a relatively higher need to consciously protect quality innovation, since efficiency innovations are more indirectly related to outcomes. By contrast, quality innovations are in a sense outputs themselves, since they aim at reshaping production processes to better serve customer needs. Thus, in order to be successful, quality innovations must be more observable to the outside than efficiency innovations, which should in turn increase the corresponding risk of imitation.

The profiling variables of the degree of innovation already provide some indications of the relationship between firm performance and distinct modes of appropriability in the small enterprise sector. In fact, appropriation methods should not only help innovators thwart imitation but also contribute to achieving company goals, i.e. enable them to garner profits from their innovations (Hurmelinna-Laukkanen and Puumalainen, 2007). Differences in the utilization of innovation protection mechanisms may thus also be due to the fact that overall appropriation strategies target different company goals. Hence, to give further indications in this regard, a number of binary variables relating to the effects of innovation activities on firm performance are created. In this way, we are able to observe which product-oriented innovation effects

[4] The full question asked in the German CIS was: Has your company used one (or more) of the following IP protection mechanisms during 2002–2004? If yes: please indicate its importance for innovation protection in your company.

[5] That is, WZ 93 ("Klassifikation der Wirtschaftszweige"), the German version of NACE Rev.1.

Table 1
Descriptive statistics on the importance of innovation protection mechanisms (*N* = number of small firms; % = share of sample).

	No utilization		Low importance		Moderate importance		High importance	
	N	%	*N*	%	*N*	%	*N*	%
Patent	1062	84.9	33	2.6	45	3.6	111	8.9
Utility model	1108	88.6	39	3.1	40	3.2	64	5.1
Industrial design	1222	97.7	24	1.9	4	0.3	1	0.1
Trademark	1069	85.5	32	2.6	61	4.9	89	7.1
Copyright	1176	94.0	29	2.3	13	1.0	33	2.6
Secrecy	832	66.5	28	2.2	117	9.4	274	21.9
Complexity of design	1016	81.2	26	2.1	79	6.3	130	10.4
Lead time advantage	799	63.9	25	2.0	82	6.6	345	27.6

Note: The total number of observations amounts to only 1251 companies in each case, since 6 observations were deleted as outliers in the later cluster analysis (see Section 3.2).

(i.e. increased range of goods/services, entering of new markets, increased market share), which process-oriented ones (improved flexibility of production/service provision, increased capacity of production/service provision, reduced labor costs per unit output, reduced materials and energy per unit output) and which effects related to product as well as to process innovations (improved quality of goods/services) had a relevant impact on the economic performance of a small firm during the reference period. Thus, it is worth noting that we do not focus only on measurements of performance related to product innovations but also on the effects of significant process innovations.

Thirdly, we investigate how innovation protection mechanisms in general and IPRs in particular complement the overall competitive strategy of small firms by lowering the threat of imitation by competitors. Several authors highlight the key role of sector-specific appropriability conditions in determining the endogenous relationship between market structure (e.g. firm size or the degree of concentration) and the rate of innovation (Cohen and Levin, 1989; Levin et al., 1985; Malerba and Orsenigo, 1993, 1997). Hence, the choice of appropriation strategies should – at least to some degree – be a rational response to external market conditions. We argue that this is especially true of small firms, since their management decisions are more straightforward in the sense that their scope for alternative strategies is limited (e.g. because of a lack of market power, a narrow customer and product base or a lack of resources or risk-reducing behavior among small business owners; see Wynarczyk et al., 1993) and because their appropriation strategies are likely to be handled by small business owners personally (Matthews et al., 2003). The evidence of Kitching and Blackburn (1998, 2003; see Section 1) already lends support to this argument, as it shows that small firms tend to adopt IPRs only under highly selective circumstances and are thus probably less likely than large firms to use IPRs routinely (for this argument, see also Arundel and Kabla, 1998). Hence, we include diverse variables in the market environment of innovative small firms that may influence the use and importance of protection mechanisms.

To begin with, the geographical market orientation is of interest (export market activities or regional business focus). Focusing solely on the regional business environment may make it easier to develop high-trust relations with customers and suppliers, thereby lessening the need for protection efforts. The contrary may hold for firms with an international orientation, where maintaining patents could be a prerequisite for the successful penetration of export markets. Nonetheless, as Baldwin and Johnson (1996) point out, small firms that are more innovative are more likely to have an export orientation than those that are less innovative. Thus, the innovativeness of exporting SMEs may be associated with a greater emphasis on knowledge protection per se.

The general dynamism of the market environment may also play a key role in determining the perceived strength of single protection mechanisms. For example, methods such as secrecy and lead time advantage are likely to be far more effective in preventing imitation by competitors than patents in industries, where short product life cycles and a fast pace of technological advance are characteristic (Hall and Ziedonis, 2001; Hurmelinna-Laukkanen et al., 2008). To account for such dynamics, we used respondents' answers to the question of whether products and services mature rapidly (short product life cycle) and whether technologies change rapidly (fast pace of technology) in their main markets.

Next we used answers to questions on the ease of substitution and the number of main competitors to assess how innovation protection practices are related to the fact that small firms often follow a differentiation or niche strategy to overcome scale-related disadvantages in innovation. We created a binary variable that equals one if a small firm reports that its products are unlikely to be substituted by those of competitors. Another variable measures whether a small firm faces more than five main competitors. To assess whether a small firm tends to operate in a market where scale economies are important, another binary variable indicates whether its main competitors are larger than it in size. Furthermore, as Iversen (2003, 2008) suggests, the relevance of IPRs in complementing a small firm's differentiation or niche strategy depends on the nature of the competition in the respective market. The author distinguishes three principal ways by which a firm can develop distinctiveness: by price, by technological performance, and in the eyes of the consumer. IPRs can help firms protect their distinct positions, either with respect to the underlying technical novelty (notably through patents or utility models) or by their distinctiveness as perceived by the customer (notably through trademarks or industrial designs). Thus, in the case of technological or design-based competition, protection by IPRs may serve as an effective instrument. On the other hand, IPRs have less significance in markets characterized by strong price competition, since selling efforts or technological performance play a lesser role in this context (Iversen, 2003, 2008). To account for such differences we use binary variables on the importance of price and non-price competition in the main markets of respondents (price, quality, technological edge, customer service and flexibility).

3. Empirical analysis for the identification of appropriation modes

3.1. Types of innovation protection mechanism: factor analysis

For two reasons, we used factor analysis to compress the eight primary variables into distinct types of innovation protection method and used the results as clustering variables in the next subsection. The first reason for this was that the grouping of correlated variables into factors avoids the overweighting of single variable sets (i.e. different types of protection mechanism). Secondly, since factor scores are a linear combination of weighted individual variables, they are likely to represent more robust variables than the

originals (Hair et al., 1998). Two standard measures are used to ensure that the primary variables are sufficiently correlated with each other to justify the application of factor analysis. Bartlett's test of sphericity (2051.39, $p < 0.000$) and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO = 0.749) both show satisfactory results. Furthermore, we apply the latent root criterion to decide on the number of factors, since it is the most commonly used approach for this aim. Accordingly, the number of factors to extract equals the number of factors with eigenvalues greater than one.

By using standard factor analysis (principal component factoring and varimax rotation), a three-factor solution is found, explaining 65% of the variance. The rotated factor loadings are shown in Table A2 (see Appendix A). The first factor accounts for the most variance and is marked by high loadings on all three informal protection mechanisms. It is thus labeled 'Informal methods'. The importance of patents and utility models for the appropriation of innovation returns loads significantly on Factor 2, whereas Factor 3 shows high loadings on industrial designs and copyrights. Patents and utility models are sought to protect new solutions to technical problems, allowing them to be summarized under the heading 'Technical IPRs'. On the other hand, industrial designs and copyrights can be described as 'Other IPRs', since, although their protection can also be related to technology-oriented areas, the subject of their protection does not lie in technical novelty. Instead, protection is given to the visual appearance of products (industrial design) and artistic creations such as books, blueprints or computer programs (copyright). The picture is less clear in the case of trademarks, however. The respective variable loads equally on the second factor and on the third. Initially, one would expect only higher loadings on the latter, since trademarks do not actually constitute a technical IPR either. They represent a sign (or combination of signs) that helps customers distinguish the products or services from those of competing firms. Yet, the loading on the second factor, as well as that on the third, is not surprising, since trademarks in particular can be effectively combined with technical IPRs. The additional use of trademarks might create brand equity for patenting firms ("Technology Brands") and significantly increase their appropriation of the returns generated by intangible technological assets (Jennewein, 2005; Ramello and Silva, 2006). In sum, therefore, we obtained a similar factor pattern to Arvanitis and Hollenstein (1996). In their analysis, a first factor relates to IPR protection and a second to secrecy, complexity of design and lead time. A third factor then refers to sales/service efforts and the retention of firm-specific human capital (appropriability mechanisms not covered in our study).

3.2. Identification and interpretation of appropriation strategies: cluster analysis

The results of the factor analysis already indicate that at least some innovation protection mechanisms are not mutually exclusive but rather complement each other effectively. To gain a better understanding of this aspect we carried out a cluster analysis of the three factors to identify different modes of appropriability. As suggested by Hair et al. (1998), we combined hierarchical and non-hierarchical methods of cluster analysis to gain the benefits of each. In a first step, hierarchical techniques were used to identify outliers and determine the number of clusters. Ward's algorithm with squared Euclidean distance as the measure of similarity led to a 4-Cluster solution.[6] Prior to this we used the single linkage method to identify outliers, since this procedure is particularly prone to chaining. The corresponding dendrogram caused us to delete six observations as outliers, reducing the dataset to 1251 firms. In a second step, to adjust the hierarchical results, the cluster centroids from the Ward method served as initial seed points for a k-means (non-hierarchical) cluster procedure. Table 2 shows the final cluster solution using the original values of the primary variables. A non-hierarchical cluster analysis with random seeds led to very similar results, demonstrating the stability of the derived solution. The robustness of the cluster results were further corroborated by a Kruskal–Wallis test, which examined whether the clusters were really distinctive in view of the primary variables. It revealed that the average values of the latter differed significantly across the four clusters.

Thus, according to the cluster results (see Table 2), four modes of appropriability are prevalent in the small enterprise sector. The 'informal protection group' (Cluster 1), comprising 241 innovative small firms (19% of the total sample), is characterized by the highest scores in all three informal protection methods. IPRs, on the other hand, seem to have almost no relevance for the appropriation of innovation returns in this group. Maintaining a lead time advantage over competitors is thereby considered as most important. Firms in the informal protection group, however, also assign on average a higher relevance to secrecy and the complexity of design. A distinctive feature of the 'patent-oriented group' (Cluster 2), of 139 members (11% of the total sample), is that technical IPRs (especially patents) are seen to be important for the protection of innovation results. Trademarks are also relevant for these innovators, which confirms the special role of trademark protection as discussed above. Apart from technical IPRs, firms in the patent-oriented group also attribute higher importance to both secrecy and lead time advantage (albeit lower than in Cluster 1), but not to complexity of design. This finding is of interest for two reasons: firstly, secrecy is often seen as the strategic alternative to patent protection with its involved disclosure requirement (Granstrand, 1999; Hussinger, 2004; Nieto and Pérez-Cano, 2004). Yet, our results imply that small firm innovators either make use of both protection mechanisms simultaneously (e.g. by patenting the codified components of an innovation and keeping core technological know-how secret) or employ them at different stages of the innovation process during the reference period (for example, patents may be highly effective in the commercialization stage, while secrecy may be more relevant in the early stages of the innovation process; see Cohen et al., 2000).[7] Secondly, patents and the complexity of design are instead used as substitutes, which corroborates the findings of Amara et al. (2008).[8] On the one hand, it can be argued that this is due to the fact that innovations in the first cluster are less patentable than those in the second and it explains why these firms compensate by using a different protection mechanism. In fact, in the case of frequent incremental improvements, complex product design is an informal, technology-based protection method ideally suited to reducing the opportunity of imitation by competitors (Päällysaho and Kuusisto, 2008; for a small firm perspective see Mazzarol and Reboud, 2009). Conversely, however, firms in the first cluster do not show a higher preference for utility models (also referred to as "petty patents" – see footnote 3). Hence, the assurance that the sheer complexity of the technological knowledge and corresponding learning effects will dissuade potential imitators may be a further reason why a number of small firms in the informal protection group do not seek

[6] Apart from a visual inspection of the dendrogram we used the results from two stopping rules implemented in our statistical software (Calinski-Harabasz pseudo-F index and the Duda-Hart Je(2)/Je(1) index) to determine the number of clusters.

[7] It might be argued, of course, that respondents referred to the protection of different innovation projects. Yet, since smaller firms are less likely to conduct different innovation projects concurrently we are of the opinion that this argument has less weight in the present context.

[8] The mutually exclusive nature of technical IPRs and complexity of design is also shown in Table A2 (see Appendix A).

Table 2
Cluster solution: mean values of the primary variables and statistical significance of cluster differences (Kruskal–Wallis test).

	Cluster of innovative small firms				d.f.	Chi-square
	1 (N = 241)	2 (N = 139)	3 (N = 71)	4 (N = 800)		
Patent	0.30	2.25	0.75	0.02	3	259.2**
Utility model	0.11	1.56	0.66	0.03	3	146.3**
Industrial design	0.00	0.03	0.44	0.00	3	26.7**
Trademark	0.35	1.01	1.28	0.13	3	98.1**
Copyright	0.02	0.00	2.04	0.01	3	177.7**
Secrecy	2.26	2.15	1.48	0.17	3	487.7**
Complexity of design	1.78	0.48	1.06	0.01	3	296.1**
Lead time advantage	2.62	2.04	1.62	0.24	3	510.0**
Label	Informal protection group	Patent-oriented group	Copyright-oriented group	Non-protection group		
Share of sample	19%	11%	6%	64%		

Note: Values are means of Likert scale responses (0 = no utilization, 1 = low importance, 2 = moderate importance, 3 = high importance).
** Report a significance level of 1%.

out IPRs. Small firms may therefore also forgo expensive patents because they simply see no need for their use.

The 'copyright-oriented group' (Cluster 3), with 71 firms (6% of the total sample), is characterized by a higher relevance of other than technical IPRs. Copyright protection in particular serves as an important protection mechanism for these innovators. Compared with the other groups, trademarks and industrial design are also more important to them in innovation protection. The low score on the industrial design variable is puzzling at first (see also Table 1). However, this might be due to the fact that in order to harmonize the German Innovation Survey with the CIS questionnaire, the term 'Industriedesign' was used instead of the more common term 'Geschmacksmuster' (Aschhoff et al., 2007). This must have caused some confusion among respondents. Thus, owing to the interrelationships between the use of copyrights and industrial design protection, as was shown by means of factor analysis in the last subsection, a higher absolute relevance of industrial design in Cluster 3 might actually be the case. The relatively greater importance of certain IPRs to innovators in the copyright-oriented group is accompanied by the use of all three informal protection methods; although it should be noted that the corresponding score levels in all cases are lower than those in the first cluster. All in all, the use of innovation protection mechanisms by firms in the third cluster seems slightly less selective than that observed in the first and second groups (e.g. because the corresponding firms also indicate little preference for technical IPRs). Finally, the results for the 'non-protection group' (Cluster 4) reveal a striking feature of the small enterprise sector: by far the most innovative small firms (64% of the total sample) made no conscious effort to protect their innovations during the reference period. Thus, in view of the methods under consideration it seems that innovators in Cluster 4 either face a lower risk of imitation than those in the remaining three groups or other factors are responsible for innovation protection efforts playing only a minor role.

4. Modes of appropriability: validation and profiling

The *within*-cluster results given in Table 3 confirm the assumption that in-house R&D activities, an engagement in innovation-related cooperation and the intensity of innovation expenditure are key drivers of variability in the appropriation strategies adopted by innovative small firms. We see significant differences in these variables across the four clusters identified in the previous section, leading us to the conclusion that the derived appropriation modes have a predictive validity. Firms in the patent-oriented group conduct in-house R&D on a permanent basis much more often than those in the other groups; they have a stronger focus on cooperative innovation; and they tend to be concentrated at the highest level of innovation expenditure. Generally, the results point to a high degree of innovativeness in these firms. The contrary is evident in the non-protection group, where the corresponding firms show by far the lowest level in the first two variables and tend to spend a relatively small percentage of their monetary resources on innovation activities. Thus, with regard to these indicators, the second and the fourth modes are, in a sense, complete opposites. Clusters 1 and 3 display values in between this range, whereby members of the former group are, on average, more inclined to continuous R&D, cooperative innovation and a higher intensity of innovation expenditure. Since the basic condition for protection under the patent system is a high degree of inventive novelty, it is evident that the less frequent use of technical IPRs by small firms may often result from a lack of this requirement because of the incremental nature of their innovations. At the same time, however, a relatively low level of investment in innovation might in many cases also reduce the need for expensive patents to appropriate sufficient rates of return on such activities. Yet, contrary to what might be expected, a large number of innovative small firms (given the relative size of Cluster 4) do not switch to informal protection methods, but forgo any attempt at innovation protection at all.

As the predictive validity of the cluster solution is confirmed, Tables 4–6 show *across*-cluster results in three relevant dimensions (industry composition by knowledge intensity; output of innovation; features of the market environment) so as to give a descriptive profile of each mode of appropriability. By examining whether the four clusters also differ in terms of the profiling variables, we gain further information on the characteristics of innovative small firms that choose a certain appropriation strategy. The results are given as the percentage of small firms in these variables that are in each cluster, since, in principle, we assume that an innovator's choice of protection methods depends on the proposed profiling dimensions (see Section 2). Furthermore, in each case these across-cluster percentages are interpreted in relation to the total sample sizes of the four clusters (i.e. the expected distribution).[9] In this way, the relative impact of a profiling variable on the relevance of a certain appropriation strategy can be assessed. Nevertheless, when profiling the cluster solution using cross-tabulations, one has to keep in mind that only a descriptive taxonomy is developed, allowing, in a strict sense, no causal inferences to be drawn.

[9] At this point, it has to be noted that not all sampled firms provided full information on all verification and profiling variables (see Table A1 in the Appendix A). Hence, in some cases the total sample shares of the clusters vary to some degree from the ones presented in Table 2.

Table 3
Predictive validity of selected variables: percentage share per cluster and statistical significance of cluster differences (Pearson's chi-square test).

	Cluster				Chi-square
	Informal protection group	Patent-oriented group	Copyright-oriented group	Non-protection group	
Permanent in-house R&D	56	75	37	16	245.26**
Cooperative innovation	34	58	25	11	183.56**
Total innovation expenditure (% of turnover)					
$0\% \leq x < 1\%$	7	9	16	31	
$1\% \leq x < 5\%$	27	24	26	36	
$5\% \leq x < 15\%$	31	21	34	20	
$x \geq 15\%$	35	46	24	13	137.59**

Note: The table shows the corresponding usage share for each cluster. For example, 56% of firms in Cluster 1 conducted in-house R&D on a permanent basis in 2002–2004.
** Report a significance level of 1%.

Table 4
Knowledge intensity of industries, distribution of firms across clusters and statistical significance of cluster differences (Pearson's chi-square test).

	Cluster				Chi-square
	Informal protection group	Patent-oriented group	Copyright-oriented group	Non-protection group	
Industry sector					
Knowledge-intensive manufacturing	26	22	6	46	
Other manufacturing	15	9	7	69	
Knowledge-intensive services	23	11	6	60	
Other services	10	1	2	87	114.09**
Total (reference case)	19	11	6	64	

Notes: The table shows the distribution of firms across clusters that responded to this question. For example, 26% of the knowledge-intensive manufacturing firms in the sample are members of the informal protection group, whose total sample share equals 19%.
** Report a significance level of 1%.

Table 5
Output of innovation, distribution of firms across clusters and statistical significance of cluster differences (Pearson's chi-square test).

	Cluster				Chi-square
	Informal protection group	Patent-oriented group	Copyright-oriented group	Non-protection group	
Type of innovator					
Product-only innovator	22	14	6	59	
Process-only innovator	8	2	4	85	
Comprehensive innovator	25	14	6	55	
Nascent innovator	13	9	7	71	69.67**
Total (reference case)	19	11	6	64	
Degree of product innovation					
Introduction of new-to-market innovations	33	27	9	31	106.23**
Introduction of new-to-firm innovations	29	20	8	43	46.33**
Total (reference case)	25	15	6	54	
Degree of process innovation					
Introduction of efficiency innovations	21	13	5	61	2.02
Introduction of quality innovations	24	11	6	59	14.07**
Total (reference case)	20	11	5	64	
Effects of innovation					
Increased range of goods/services	23	13	6	57	47.42**
Entering of new markets	23	15	7	55	46.93**
Increased market share	25	15	8	51	63.21**
Improved quality in goods/services	22	11	6	61	10.33*
Improved flexibility of production/service provision	20	9	7	64	9.20*
Increased capacity of production/service provision	21	10	6	64	3.66
Reduced labor costs per unit output	22	10	6	61	2.23
Reduced materials and energy per unit output	21	14	6	58	3.66
Total (reference case)	20	12	6	63	

Notes: The table shows the distribution of firms across clusters that responded to these questions. For example, 14% of the product-only innovators in the sample are members of the patent-oriented group, whose total sample share equals 11%.
** Report a significance level of 1%.
* Of 5%.

Table 6
Market environment, distribution of firms across clusters and statistical significance of cluster differences (Pearson's chi-square test).

	Cluster				Chi-square
	Informal protection group	Patent-oriented group	Copyright-oriented group	Non-protection group	
Geographical markets					
Export market activities	25	22	7	46	127.58**
Regional business focus	10	2	4	84	76.47**
Total (reference case)	19	11	6	64	
Features of competition					
Short product life cycle	25	12	6	58	15.54**
Fast pace of technology	22	12	6	60	8.26*
Difficult substitution	22	15	7	56	23.74**
Total (reference case)	19	11	6	64	
Main competitors					
More than 5 main competitors	16	9	5	69	10.51*
Main competitors are larger in size	21	14	7	59	13.00**
Total (reference case)	19	11	6	64	
Important factors for competition					
Price	15	9	5	72	27.16**
Technological edge	33	23	6	38	54.35**
Quality	19	12	6	62	2.01
Customer service and flexibility	21	7	4	69	13.94**
Total (reference case)	19	11	6	64	

Notes: The table shows the distribution of firms across clusters that responded to these questions. For example, 46% of the exporting firms in the sample are members of the non-protection group, whose total sample share equals 64%.
** Report a significance level of 1%.
* Of 5%.

Table 4 shows that firms from each of the four industry sectors under consideration are distributed across all the derived clusters. However, the industry composition of individual modes appears to be concentrated in certain ways. Firms that are represented in service industries with low knowledge intensity are seldom found in one of the first three groups, while those in the non-protection group frequently belong to this sector. Furthermore, the industry composition of Clusters 1 and 2 appears to follow a specific pattern. Operating in knowledge-intensive manufacturing or service sectors seems to go along with a higher relevance of the informal protection mode. The patent-oriented group, when compared to its sample size, is even characterized relatively often by knowledge-intensive manufacturing firms. In the case of the copyright-oriented mode, it appears that an above-average number of manufacturing firms from industries with lower knowledge intensity use this appropriation strategy, although innovators from knowledge-intensive manufacturing and service industries also seem to be well represented in this group. To sum up, as the results given in Table 4 indicate, small firms from more innovative industries are more inclined than others to consider innovation protection mechanisms to be important.

From the information given in Table 5, it is evident that a small firm's mode of appropriability varies strongly with the type of innovator, the underlying degree of novelty and the corresponding effects on firm performance. The distribution of firms across the four clusters according to basic types of innovator indicates, once again, a specific pattern in the first and second modes. Both are chosen relatively often by product-only innovators and comprehensive innovators. On the other hand, the process-only innovator, in particular, is seldom related to the patent-oriented appropriation group. Instead, the number of such innovators is clearly above average in the non-protection group. This finding lends support to the assumption presented in Section 2 that in the case of process technology, because of its lower observability and codifiability, the appropriability conditions for innovative firms differ significantly from those of product technology. Yet, because of this, process-only innovators seem more inclined to forgo any kind of innovation protection method than to show a higher preference for secrecy (as is often assumed in the literature in order to explain the less frequent use of patents by process innovators; see, for example, Arundel, 2001; Hanel, 2008; Nieto and Pérez-Cano, 2004). In relative terms, the non-protection group is also frequently composed of nascent innovators. Hence, for some firms choosing the fourth mode, the use of protection methods may be less relevant because they have not yet completed their current innovation projects. These results demonstrate that, given their specific types of innovation, small firms tend to be selective in the adoption of appropriation strategies.

Table 5 further confirms that the decision by small firms of whether to use innovation protection methods or not is, at least in part, a function of their innovativeness. On the one hand, in relative terms the non-protection group is characterized much less often than the other clusters by firms that introduce any kind of significant product innovation. This result is most striking in the case of new-to-market innovations. In particular, a focus on such innovations seems to be a specific characteristic of the patent-oriented group, which again points to the innovativeness of these firms. The opposite is true of firms in the fourth group. The number of firms introducing new-to-market innovations is also relatively large in the first and third clusters. In the case of new-to-firm innovations, the results are similar but less pronounced, possibly because they may also be imitations of competitors' products. On the other hand, there is much less variation in the relevance of the four appropriation modes where efficiency innovations are concerned, which suggests that, owing to a lower overall risk of imitation, this kind of significant process innovation requires less protection. Hence, the higher degree of tacitness of knowledge that is typically embodied in efficiency innovations may often be sufficient in itself to successfully appropriate the corresponding returns. Quality innovations are – relatively speaking – frequently introduced in the informal

protection group. As with the results for efficiency innovations, this is worth noting, since it may also imply that other appropriation strategies function equally, or even more, effectively for this kind of significant process innovation than those based, for example, on patent protection.

Table 5 further elaborates on the latter results by showing the relationship between various effects of innovation on firm performance and the identified clusters. In this way it is confirmed that, compared with the reference case, all appropriation strategies other than the non-protection mode are relatively often chosen by respondents reporting product-oriented effects (increased range of goods/services, entering of new markets, increased market share) having a relevant impact. We interpret this finding as indicating that, in general, the use of formal and informal protection methods can assist small firms in successfully appropriating the returns from their product innovations. However, as the above results already suggest, the same may not hold true for the appropriability of process innovations. Much less variation is observed between the fourth and the other groups in the case of process-related innovation effects, a finding that is not surprising, given the relatively high number of efficiency and quality innovations and the large share of process-only innovators in the non-protection group. Hence, concerning the appropriation of process innovation returns, the results indicate that the fourth mode is not necessarily less effective than other appropriation strategies.

With respect to the role of product-oriented innovation effects, Table 5 also indicates that the first three appropriation modes do not differ much from each other in relative terms. Thus, depending on their specific business contexts, both IPR-based and informal appropriation strategies seem to work effectively for product-innovating small firms. Yet, it is worth noting that, compared with the other modes, the patent-oriented group is relatively less frequently made up of respondents who report that process-related innovation effects have a relevant impact on their firm performance. Perhaps most interesting in this regard are the improvement of quality in goods and services and the better production and service provision in terms of flexibility and capacity as outcomes of innovation. In fact, the ability to offer superior customer service and to adjust product quality to meet particular customer needs in a fast, flexible and incremental way is often seen as a distinct advantage of typical small firms in their innovation efforts (see Section 1). Since even the non-protection group is about average with respect to these innovation effects, we interpret this finding (together with the results of Table 3) as an indication that the less frequent use of technical IPRs by smaller firms should also be related to the specific nature of their innovation regime, an argument further supported by the data given in Table 6.

To begin with, as expected, the appropriation strategies chosen by innovative small firms tend to be aligned to their market environments (see Table 6). One striking feature is that firms actively engaged in innovation protection tend to operate in markets other than those of firms that forgo any attempt at innovation protection. An engagement in exports is related to a much higher relevance of IPR-based or informal appropriation strategies, whereas the number of firms that focus solely on their regional business environment is clearly above-average in the non-protection group. Small firm innovators facing a more dynamic market environment in terms of a product's life cycle and the pace of technological advance are also relatively often found in one of the first three clusters. In addition, compared with the reference case, having larger counterparts seems to be a specific feature of the first three appropriation modes, which is probably why the members of these groups, on average, are less able to compete on price. Thus, to overcome scale-related disadvantages in innovation, many small firms in the first three groups seem to pursue a differentiation or niche strategy, complemented by the use of several methods to protect this distinctiveness (in comparison to their total sample sizes their products are relatively often difficult to substitute and they tend to have fewer main competitors). On the other hand, facing strong price competition is frequently related to an affiliation to the fourth cluster, a further explanation for why innovation protection efforts have low overall relevance in this group (protection methods such as IPRs have less applicability in cases where firms compete on price only).

In Table 6 we see that there is also some variation between the first three modes, which may indicate a higher effectiveness of certain protection methods in matching specific market environments. A relatively large number of small firms active in export markets choose the patent-oriented mode, which once again reflects their innovative abilities. Moreover, maintaining patents is probably a prerequisite for successful entry into foreign markets. Yet, under certain circumstances protection methods other than patents tend to be preferred. For example, the great emphasis on informal protection methods in the first group may also be related to the fact that a clearly above-average number of firms facing shorter product life cycles choose the first appropriation mode (as lead time and secrecy should be particularly effective in this situation). It seems that this finding also holds true for the pace of technological advance but the cluster differences are slightly less pronounced in this case. Furthermore, logically enough, small firms in the copyright-oriented group relatively seldom compete on technological advances, as compared with members of the first two appropriation modes. The strong science base of the patent-oriented group, on the other hand, is corroborated by the fact that this mode is, to a large extent, chosen by small firms showing a commitment to technological competition. No significant differences across the four appropriation modes are found with respect to innovators that operate in markets where quality of product and service are vital to remaining competitive. However, the number of small firms that have a strong customer orientation in terms of service and flexibility is below-average in the patent- and copyright-oriented groups. This finding is of special interest for two reasons. Firstly, in line with the above discussion, it indicates that complementary assets such as customer-oriented service and manufacturing capabilities may often carry more weight than the adoption of (technical) IPRs when it comes to the successful appropriation of innovation returns in the small enterprise sector. Secondly, it points to a further reason why complexity of product design rather than patent protection works effectively for a number of small firms. Usually less standardized and – based on firm-specific skills and competence in problem solving – frequently tailored to meet individual customer needs, small firm innovations are often likely to go hand in hand with higher costs and more time for reverse-engineering from the perspective of the potential imitator, all of which makes the complexity of design an effective appropriation method and lowers the need for patent protection.

5. Conclusion and implications for policy and research

This paper has examined various modes of appropriability in the small enterprise sector. Our empirical analysis has revealed that innovative small firms can be divided into four distinct groups according to the kind of appropriation strategy they adopt. One finding is that for many innovative small firms the main issue is not whether to use IPRs or not, but whether to protect their innovations from imitation at all. Furthermore, the results show that formal and informal protection mechanisms should not be seen as mutually exclusive, since small firm innovators combine several methods to form their appropriation strategies. With the exception of the non-protection group, informal protection mechanisms play a significant role in all appropriation modes. Yet this is only

Table 7
Classification of innovative small firms according to their mode of appropriability.

Cluster	1	2	3	4
Appropriation strategy				
Protection mechanisms (dominant ones are marked in bold)	Secrecy, complexity of design, **lead time**	**Patent**, utility model, trademark, secrecy, lead time	Trademark, **copyright**, secrecy, complexity of design, lead time	No usage of innovation protection mechanisms
Share ($N = 1251$)	19%	11%	6%	64%
Input of innovation				
In-house R&D	Medium frequency	High frequency	Medium frequency	Low frequency
Cooperative innovation	Medium frequency	High frequency	Medium frequency	Low frequency
Expenditure on innovation	Medium intensity	High intensity	Medium intensity	Low intensity
Industry sector	Knowledge-intensive manufacturing and service firms	Knowledge-intensive manufacturing firms	Well represented in all sectors apart from non-knowledge-intensive services	Non-knowledge-intensive manufacturing and service firms
Output of innovation				
Type of innovator	Comprehensive innovators Product-only innovators	Comprehensive innovators Product-only innovators	All types of innovators	Process-only innovators Nascent innovators
Degree and effects of innovation	Quality innovations	New-to-market innovations New-to-firm innovations Relatively low relevance of most effects related to process innovations	No specificities	Lower engagement in significant product innovation Lower relevance of product-oriented innovation effects
Market environment				
Geographical markets	Intermediate position	Strong international orientation	Intermediate position	Strong regional business focus
Features of competition	Difficult of substitution Shorter product life cycles Faster pace of technology	Difficult substitution Intermediate position in terms of market dynamism	Difficult substitution Intermediate position in terms of market dynamism	Easy substitution Longer product life cycles Slower pace of technology
Main competitors	Smaller number of main competitors Main competitors often larger in size	Smaller number of main competitors Main competitors often larger in size	Smaller number of main competitors Main competitors often larger in size	Larger number of main competitors Main competitors often similar in size
Important factors for competition	Non-price competition Technological edge	Non-price competition Technological edge Relatively low relevance of customer service and flexibility	Non-price competition Relatively low relevance of customer service and flexibility	Price competition

Note: The assignment of attributes to the classification categories was oriented on the observed specificities of each appropriation mode in comparison with the others. Thus, for the sake of overview, only key characteristics are highlighted.

true in the case of secrecy and lead time advantage, since these two methods are either complemented by technical and other IPRs or are used in combination with complexity of design as a technology-based informal protection method. Hence, our findings imply that, on average, patents and other IPRs are of low importance for innovation protection purposes in the small enterprise sector. Informal protection methods and especially the non-protection mode play a much more dominant role. Nevertheless, from the results, it is also evident that in a lesser proportion of the small enterprise sector the use of IPRs (in combination with informal protection mechanisms) is perceived to be of significant importance for the appropriation of innovation returns.

The validation and profiling of the appropriation modes identified has shown that the relevance of various protection methods can be interpreted by their potential availability and efficacy in specific business contexts (for a brief overview see Table 7). As expected, the degree of innovativeness plays a major role. Members of the patent-oriented group are much more innovative than other small firms in terms of indicators such as continuity of in-house R&D, cooperative innovation or the introduction of new-to-market innovations. Hence, given the relatively small size of this cluster, patents may be less available for a large number of small firms, as they are more likely to innovate incrementally. However, at the same time, a lower level of investment in innovation might in many cases also reduce the need for expensive patents in appropriating sufficient rates of return on innovation activities. In line with the latter argument, our results further indicate that the importance of each appropriation mode is also related to other factors (e.g. the type of innovator, the kind of significant innovation, and corresponding effects on firm performance or the general market environment) which in many cases even make the non-protection mode a reasonable choice.

With respect to the degree of innovation and the corresponding effects on small firm performance, we have found some indications that each appropriation mode – depending on the object of protection – can be effective regarding company goals. These results have given us deeper insights into the kinds of innovation that are protected by certain types of protection mechanism. Product innovation returns seem more inclined to be protected by appropriation strategies that actively employ informal protection methods only or also use IPRs. At this point, the first three appropriation modes do not differ much from each other, which suggests that

they are equally important for product-innovating small firms in a variety of business contexts. Yet, when it comes to the appropriation of process-innovation returns, our results indicate that the non-protection mode is not necessarily less effective than other appropriation strategies. Furthermore, the patent-oriented appropriation mode has been observed to be relatively less characterized by measures typically associated with innovation in most small firms (e.g. with respect to certain process-related innovation effects and customer orientation as a success factor in securing and sustaining a competitive advantage) than, for example, the first appropriation mode with its strong emphasis on informal protection methods. Thus, we conclude that apart from issues of cost and complexity, the low propensity of smaller firms to adopt IPRs should also be related to the specific nature of their innovation regime. In summing up, this study implies that the use of IPRs by innovative small firms is highly selective. This by no means ignores the fact that IPRs can be a crucial factor in their appropriation strategy. However, many small firm innovators do not perceive IPRs to be important, since they either forgo active protection efforts entirely or find alternative means of protection more relevant to the successful appropriation of innovation returns.

Our results have several implications for innovation policies that target small businesses. First of all we were able to account for the heterogeneity among innovative small firms when it comes to different appropriation strategies. In this way, policy makers aiming to improve the appropriability conditions of smaller firms are in a better position to meet the specific needs of certain subgroups of SMEs. In particular, it is important to be aware that innovative small firms – depending on their specific business contexts – either forgo any attempt at innovation protection or actively combine the use of secrecy and lead time with technical IPRs or with complexity of design. From a policy perspective, the present study therefore indicates that the less frequent use of IPRs by smaller firms does not necessarily give rise to public concern, since it should, apart from the resource and capability constraints that SMEs may face in coping with the IPR system, also be related to the specific nature of their innovation regime. Thus, even considering that our data analysis did not provide information on the relationship between the choice of appropriation strategy and overall firm performance (e.g. in profitability or productivity), we can conclude that non-IPR-oriented appropriation strategies are often a reasonable choice for small firm innovators, which in turn implies that easier and cheaper access to IPRs does not necessarily lead to a higher use by SMEs. Moreover, the fostering of IPR protection in such parts of the small enterprise sector that do not depend on such means of protection in terms of appropriability may make it harder for corresponding companies to profit from knowledge-sharing activities and thus may inhibit further innovation (see Hurmelinna et al., 2007). Hence, although this does not make policy attempts to enhance the effective use of IPRs by SMEs irrelevant, policy makers should nevertheless bear in mind that a corresponding target group is more limited than might be expected at first glance. Either way, the decision of innovative small firms whether or not to use IPRs should be well informed and take into account both the potential cost and the potential benefits of using formal protection methods. Small business owners, for example, who prefer complexity of product design as a protection method for patentable inventions should be aware that legal action against imitators may be impossible if their protection efforts prove unsuccessful. The policy implication here is that small firm innovators should always be familiar with the constraints and opportunities of the IPR system.

The fact that numerous innovative small firms do not use IPRs because they attach little importance to innovation protection as a whole also deserves attention. As our results imply, a higher level of innovativeness strongly increases the probability that small firms become concerned about the appropriation of innovation results and consequently perceive the use of formal or informal protection methods to be important. Thus, policy makers may first of all allocate their resources to promoting general innovative activities in small firms, especially those targeted at developing product innovations, than trying to achieve this goal primarily in an indirect way through the incentive effects of a growing use of IPR protection by small firms.

One limitation of our study is the lack of data on alternative means of protection which are particularly relevant to small firms in forming a successful appropriation strategy. Future research efforts should therefore more explicitly consider the role of knowledge tacitness, since we expect this protection mechanism to work more effectively for small rather than for large firms. In this regard, although companies with a strong tacit knowledge base, for example, also tend to opt for secrecy protection (see González-Álvarez and Nieto-Antolín, 2007), the human resource management of innovative small firms, in particular, is worth investigation in the context of appropriability. This is because the hiring away of key employees is often the only way for imitators to replicate a company's knowledge assets with a strong tacit component. Furthermore, from this study we see that additional insights are required into the role that complementary assets play in the appropriation of innovation returns in small firms. Future work should also explore in more detail the causal relationship between various modes of appropriability and firm performance. Our empirical analysis has shown that the appropriation strategies of small firms can differ from each other because they target other company goals. However, in our data analysis the focus was on various effects of innovation as (intermediate) indicators of firm performance. Moreover, we laid our emphasis on significant differences across clusters after they had been identified and validated to further develop a descriptive taxonomy, allowing, in a strict sense, no causal inferences to be drawn between cluster affiliation and proxies of performance. Hence, on the basis of this study one might determine by means of regression analysis whether distinct appropriation strategies are equivalent in economic terms by estimating their impact on an adequate measure of overall firm performance once the impact of a certain number of independent variables has been controlled for.[10] Finally, our study has not made a direct comparison of the appropriation strategies between small and large firms. An in-depth exploration of potential differences in this regard might be a challenge for future research.

[10] In this regard see, for example, Arvanitis and Hollenstein (1999) who analyzed the influence of single innovation protection mechanisms on the impact that knowledge capital has on firm performance in a Cobb–Douglas production function setting.

Appendix A.

Table A1
Description of variables used for validating and profiling the cluster solution; reference period: 2002–2004.

Variable	*N*	Description
Variables for validating the cluster solution		
Permanent in-house R&D	1055	1 if firm conducted in-house R&D on a permanent basis, 0 otherwise
Cooperative innovation	1197	1 if firm was engaged in innovation-related cooperation with other firms or scientific institutions, 0 otherwise
Total innovation expenditure (% of turnover)	1024	1 if firm's intensity of total innovation expenditure is: $0 \leq x < 1\%$ 2 if firm's intensity of total innovation expenditure is: $1 \leq x < 5\%$ 3 if firm's intensity of total innovation expenditure is: $5 \leq x < 15\%$ 4 if firm's intensity of total innovation expenditure is: $x \geq 15\%$
Variables for profiling the cluster solution		
Industry sector	1251	1 if firm's industry is classified as knowledge-intensive manufacturing 2 if firm's industry is classified as other manufacturing 3 if firm's industry is classified as knowledge-intensive services 4 if firm's industry is classified as other services
Type of innovator	1233	1 if firm was only active in product innovations 2 if firm was only active in process innovations 3 if firm was active in product and process innovations 4 if firm reports only innovation projects not yet completed
Introduction of new-to-market innovations	787	1 if firm introduced product innovations that had not yet been supplied to the respective market segment, 0 otherwise
Introduction of new-to-firm innovations	794	1 if firm introduced product innovations that had no predecessors in the firm's range of products and services, 0 otherwise
Introduction of efficiency innovations	536	1 if firm introduced process innovations that led to a decrease in unit costs of production, 0 otherwise
Introduction of quality innovations	545	1 if firm introduced process innovations that led to an increase in the quality of products or services, 0 otherwise
Increased range of goods/services	1169	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Entering of new markets	1166	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Increased market share	1156	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Improved quality in goods/services	1169	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Improved flexibility of production/service provision	1160	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Increased capacity of production/service provision	1159	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Reduced labor costs per unit output	1163	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Reduced materials and energy per unit output	1159	1 if firm considered the impact of this innovation effect to be "high" or "moderate" on a 4-point Likert scale, 0 otherwise
Export market activities	1243	1 if firm had any exports, 0 otherwise
Regional business focus	1243	1 if firm only served local or regional markets within a range of about 50 km, 0 otherwise
Short product life cycle	1233	1 if firm "strongly agrees" or "agrees" on a 4-point Likert scale that products or services mature rapidly in its main market, 0 otherwise
Fast pace of technology	1238	1 if firm "strongly agrees" or "agrees" on a 4-point Likert scale that technologies change rapidly in its main market, 0 otherwise
Difficult substitution	1233	1 if firm "strongly disagrees" or "disagrees" on a 4-point Likert scale that its products are easily substituted by those of competitors in its main market, 0 otherwise
More than 5 main competitors	1244	1 if firm has more than 5 main competitors, 0 otherwise
Main competitors are larger in size	1218	1 if firm's main competitors are larger in size, 0 otherwise
Price	1236	1 if firm considers price to be an important factor of competition in its main market, 0 otherwise
Technological edge	1215	1 if firm considers technological edge to be an important factor of competition in its main market, 0 otherwise
Quality	1234	1 if firm considers quality to be an important factor of competition in its main market, 0 otherwise
Customer service and flexibility	1236	1 if firm considers customer service and flexibility to be an important factor of competition in its main market, 0 otherwise

Table A2
Factor analysis of the importance of protection mechanisms (principal component factoring, varimax rotated factor loadings).

	Factor 1	Factor 2	Factor 3
Patent	0.256	0.762	−0.001
Utility model	0.085	0.797	0.118
Industrial design	−0.123	0.276	0.707
Trademark	0.198	0.446	0.448
Copyright	0.177	−0.068	0.821
Secrecy	0.774	0.329	−0.007
Complexity of design	0.821	−0.088	0.142
Lead time advantage	0.823	0.224	0.034
Interpretation	Informal methods	Technical IPRs	Other IPRs
Variance explained	34.6%	17.1%	13.0%

References

Amara, N., Landry, R., Traoré, N., 2008. Managing the protection of innovations in knowledge-intensive business services. Research Policy 37 (9), 1530–1547.

Appiah-Adu, K., Singh, S., 1998. Customer orientation and performance: a study of SMEs. Management Decision 36 (6), 385–394.

Arundel, A., Kabla, I., 1998. What percentage of innovations are patented? Empirical estimates for European firms. Research Policy 27, 127–141.

Arundel, A., 2000. Patents – the viagra of innovation policy?, internal report for the project Innovation Policy in a Knowledge-Based Economy commissioned by the European Commission. Retrieved from http://www.edis.sk/ekes/patents.pdf (accessed 06.07.10).

Arundel, A., 2001. The relative effectiveness of patents and secrecy for appropriation. Research Policy 30 (4), 611–624.

Arvanitis, S., Hollenstein, H., 1996. Industrial innovation in Switzerland: a model-based analysis with survey data. In: Kleinknecht, A. (Ed.), Determinants of Innovation. The Message from New Indicators. Macmillan Press, Basingstoke, pp. 13–62.

Arvanitis, S., Hollenstein, H., 1999. Appropriability, technological knowledge and firm performance: an empirical analysis with Swiss cross-section firm data. In: Oppenländer, K.H., Poser, G., Waller, S. (Eds.), Selected papers submitted to the 23rd Ciret Conference 1997 in Helsinki, CIRET-Studien 53. München, pp. 65–80.

Aschhoff, B., Blind, K., Ebersberger, B., Fraaß, B., Rammer, C., Schmidt, T., 2007. Schwerpunktbericht zur Innovationserhebung 2005. Bericht an das Bundesministerium für Bildung und Forschung (BMBF). ZEW-Dokumentation Nr. 07-03. Mannheim.

Baldwin, J., Johnson, J., 1996. Business strategies in more- and less-innovative firms in Canada. Research policy 25 (5), 785–804.

Baldwin, J., Gellatly, G., 2003. Innovation Strategies and Performance in Small Firms. Edward Elgar, Cheltenham, UK.

Bosworth, D., Webster, E., 2006. An economic perspective. In: Bosworth, D., Webster, E. (Eds.), The Management of Intellectual Property. Edward Elgar, Cheltenham, UK, pp. 85–107.

Cohen, W.M., Levin, R.C., 1989. Empirical studies of innovation and market structure. In: Schmalensee, R., Willigand, R.D. (Eds.), Handbook of Industrial Organization, vol. 2. North-Holland, Amsterdam, pp. 1059–1107.

Cohen, W.M., Nelson, R.R., Walsh, J.P., 2000. Protecting their intellectual assets: appropriability conditions and why U.S. manufacturing firms patent (or not). NBER Working Papers Series (7552).

Curran, J., Blackburn, R.A., 2001. Researching the Small Enterprise. SAGE Publications, London.

Dosi, G., Marengo, L., Pasquali, C., 2006. How much should society fuel the greed of innovators? On the relations between appropriability, opportunities and rates of innovation. Research Policy 35 (8), 1110–1121.

European Commission, 2006. Putting knowledge into practice: A broad-based innovation strategy for the EU – Communication from the Commission to the Council, The European Parliament, The European Economic and Social Committee, and the Committee of Regions, COM (2006) 502, Brussels, Belgium. Retrieved from http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0502en01.pdf (accessed 07.06.10).

Evangelista, R., 2000. Sectoral patterns of technological change in services. Economics of Innovation and New Technology 9 (3), 183–221.

González-Álvarez, N., Nieto-Antolín, M., 2007. Appropriability of innovation results: an empirical study in spanish manufacturing firms. Technovation 27 (5), 280–295.

Gopalakrishnan, S., Bierly, P., Kessler, E.H., 1999. A reexamination of product and process innovations using a knowledge-based view. The Journal of High Technology Management Research 10 (1), 147–166.

Granstrand, O., 1999. The Economics and Management of Intellectual Property: Towards Intellectual Capitalism. Edward Elgar, Cheltenham, UK.

Greenhalgh, C., Rogers, M., 2007. The value of intellectual property rights to firms and society. Oxford Review of Economic Policy 23 (4), 541–567.

Grupp, H., Legler, H., Jungmittag, A., Schmoch, U., 2000. Hochtechnologie 2000 – Neudefinition der Hochtechnologie für die Berichterstattung zur technologischen Leistungsfähigkeit Deutschlands. Karlsruhe/Hannover.

Guellec, D., Van Pottelsberghe de la Potterie, B., 2007. The Economics of the European Patent System. IP Policy for Innovation and Competition. Oxford University Press, Oxford.

Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1998. Multivariate Data Analysis, fifth ed. Prentice Hall, Upper Saddle River, NJ.

Hall, B.H., Ziedonis, R.H., 2001. The patent paradox revisited: An empirical study of patenting in the US semiconductor industry, 1979-1995. The Rand Journal of Economics 32 (1), 101–128.

Hall, M., Oppenheim, C., Sheen, M., 2003. Barriers to the use of patent information in SMEs. In: Blackburn, R.A. (Ed.), Intellectual Property and Innovation Management in Small Firms. Routledge, London, New York, pp. 144–160.

Hanel, P., 2008. The use of intellectual property rights and innovation by manufacturing firms in Canada. Economics of Innovation and New Technology 17 (3), 285–309.

Harabi, N., 1995. Appropriability of technical innovations. An empirical analysis. Research Policy 24 (6), 981–992.

Hollenstein, H., 2003. Innovation modes in the Swiss service sector: a cluster analysis based on firm-level data. Research Policy 32 (5), 845–864.

Hurmelinna-Laukkanen, P., Puumalainen, K., 2007. Nature and dynamics of appropriability: strategies for appropriating returns on innovation. R&D Management 37 (2), 95–112.

Hurmelinna-Laukkanen, P., Sainio, L.-M., Jauhiainen, T., 2008. Appropriability regime for radical and incremental innovations. R&D Management 38 (3), 278–289.

Hurmelinna-Laukkanen, P., 2009. The availability, strength and efficiency of appropriability mechanisms – protecting investments in knowledge creation. International Journal of Technology Management 45 (3), 282–290.

Hurmelinna, P., Kyläheiko, K., Jauhiainen, T., 2007. The Janus face of the appropriability regime in the protection of innovations: theoretical re-appraisal and empirical analysis. Technovation 27 (3), 133–144.

Hussinger, K., 2004. Is silence golden? Patents versus secrecy at the firm level. Centre for European Economic Research (ZEW), Discussion Paper 04-78.

Iversen, E.J., 2003. Norwegian small and medium-sized enterprises and the intellectual property rights system: exploration and analysis, a study carried out for the World Intellectual Property Organization (WIPO), Retrieved from http://www.wipo.int/sme/en/documents/research/norway/norway_study.pdf (accessed 04.06.10). Oslo.

Iversen, E.J., 2008. IPRs and Norwegian enterprises: diversification of innovative efforts in Norwegian firms. In: Carayannis, E.G., Kaloudis, A., Mariussen, A. (Eds.), Diversity in the Knowledge Economy and Society: Heterogeneity, Innovation and Entrepreneurship. Edward Elgar, Cheltenham, UK, pp. 191–216.

Jantunen, A., Hurmelinna-Laukkanen, P., 2006. Entrepreneurial orientation, appropriability regimes and innovation performance. International Journal of Learning and Intellectual Capital 3 (2), 153–166.

Janz, N., Ebling, G., Gottschalk, S., Niggemann, H., 2001. The Mannheim innovation panels (MIP and MIP-S) of the Centre for European Economic Research (ZEW). Schmollers Jahrbuch – Zeitschrift für Wirtschafts – und Sozialwissenschaften 121, 123–129.

Jennewein, K., 2005. Intellectual Property Management: The Role of Technology-brands in the Appropriation of Technological Innovation. Physica-Verlag, Heidelberg.

Jensen, M.-B., Johnson, B., Lorenz, E., Lundvall, B.-Å., 2007. Forms of knowledge and modes of innovation. Research Policy 36 (5), 680–693.

Jensen, P.H., Webster, E., 2006. Firm size and the use of intellectual property rights. The Economic Record 82 (256), 44–55.

de Jong, J., Marsili, O., 2006. The fruit flies of innovations: a taxonomy of innovative small firms. Research Policy 35 (2), 213–229.

Kitching, J., Blackburn, R.A., 1998. Intellectual property management in the small and medium enterprise (SME). Journal of Small Business and Enterprise Development 5 (4), 327–335.

Kitching, J., Blackburn, R.A., 2003. Innovation, intellectual property and informality: evidence from a study of small enterprises and some implications for policy. In: Blackburn, R.A. (Ed.), Intellectual Property and Innovation Management in Small Firms. Routledge, London, New York, pp. 16–34.
König, H., Licht, G., 1995. Patents, R&D and innovation. Evidence from the Mannheim innovation panel. IFO-Studien 41 (4), 521–544.
Lanjouw, J.O., Schankerman, M., 2004. Protecting intellectual property rights: are small firms handicapped? The Journal of Law & Economics 47 (1), 45–74.
Laursen, K., Salter, A., 2005. My precious. The role of appropriability strategies in shaping innovative performance. DRUID Working Paper No. 05-02, Danish Research Unit for Industrial Dynamics.
Leiponen, A., Byma, J., 2009. If you cannot block, you better run: small firms, cooperative innovation, and appropriation strategies. Research Policy 38 (9), 1478–1488.
Levin, R.C., Cohen, W.M., Mowery, D.C., 1985. R&D appropriability, opportunity, and market structure: new evidence on some Schumpeterian hypothesis. American Economic Review, Papers and Proceedings 75 (2), 20–24.
Levin, R.C., Klevorick, A.K., Nelson, R.R., Winter, S.G., 1987. Appropriating the returns from industrial research and development. Brookings Papers on Economic Activity 3, 783–831.
López, A., 2009. Innovation and appropriability: empirical evidence and research agenda. In: World Intellectual Property Organization (Ed.), The Economics of Intellectual Property. Suggestions for Further Research in Developing Countries and Countries with Economies in Transition. , pp. 1–32, Retrieved from http://www.wipo.int/export/sites/www/ip-development/en/economics/pdf/wo_1012_e_ch_1.pdf (accessed 16.05.10).
Macdonald, S., 2004. When means become ends: considering the impact of patent strategy on innovation. Information Economics and Policy 16 (1), 135–158.
Malerba, F., Orsenigo, L., 1993. Technological regimes and firm behavior. Industrial and Corporate Change 2 (1), 45–71.
Malerba, F., Orsenigo, L., 1997. Technological regimes and sectoral patterns of innovative activities. Industrial and Corporate Change 6 (1), 83–117.
Malerba, F., 2002. Sectoral systems of innovation and production. Research Policy 31 (2), 247–264.
Mansfield, E., 1986. Patents and innovation: an empirical study. Management Science 32 (2), 173–181.
Matthews, D., Pickering, J., Kirkland, J., 2003. A strategic approach to managing intellectual property. In: Blackburn, R.A. (Ed.), Intellectual Property and Innovation Management in Small Firms. Routledge, London, New York, pp. 35–54.
Mazzarol, T., Reboud, S., 2009. The Strategy of Small Firms. Strategic Management and Innovation in the Small Firm. Edward Elgar, Cheltenham, UK.
Nieto, M., Pérez-Cano, C., 2004. The influence of knowledge attributes on innovation protection mechanisms. Knowledge and Process Management 11 (2), 117–126.
Nooteboom, B., 1994. Innovation and diffusion in small firms: theory and evidence. Small Business Economics 6 (5), 327–347.
Päällysaho, S., Kuusisto, J., 2008. Intellectual property protection as a key driver of service innovation: an analysis of innovative KIBS businesses in Finland and the UK. International Journal of Services Technology and Management 9 (3/4), 268–284.
Pavitt, K., 1984. Sectoral patterns of technical change: towards a taxonomy and a theory. Research Policy 13 (6), 343–373.
Penrose, E.T., 1959. The Theory of the Growth of the Firm. Blackwell, Oxford.
PRO INNO Europe, 2007. A memorandum on removing barriers for a better use of IPR by SMEs, A Report for the Directorate-General for Enterprise and Industry (European Commission) by an IPR Expert Group, Paper No. 3, Retrieved from http://www.proinno-europe.eu/promotion-pro-inno-europe-results/page/publications (accessed 15.07.10).
Radauer, A., Streicher, J., Ohler, F., 2007. Benchmarking National and Regional Support Services for SMEs in the Field of Intellectual and Industrial Property, Final Benchmarking Report on Behalf of the European Commission, Austrian Institute for SME Research. Retrieved from http://www.insme.org/documents/Benchmarking-Report-SME.pdf (accessed 02.07.10).
Ramello, G.B., Silva, F., 2006. Appropriating signs and meaning: the elusive economics of trademark. Industrial and Corporate Change 15 (6), 937–963.
Rammer, C., Czarnitzki, D., Spielkamp, A., 2009. Innovation success of non-R&D-performers: substituting technology by management in SMEs. Small Business Economics 33 (1), 35–58.
Rothwell, R., 1983. Innovation and firm size: a case for dynamic complementarity; or, is small really so beautiful? Journal of General Management 8 (3), 5–25.
Sattler, H., 2003. Appropriability of product innovations: an empirical analysis for Germany. International Journal of Technology Management 26 (5-6), 502–516.
Scotchmer, S., 2004. Innovation and Incentives. MIT Press, Cambridge, Massachusetts.
Teece, D.J., 1986. Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. Research Policy 15 (6), 285–305.
Teece, D.J., 2002. Managing Intellectual Capital. Organizational, Strategic, and Policy Dimensions. Oxford University Press, Oxford.
Teece, D.J., 2003. The strategic management of technology and intellectual property. In: Faulkner, D.O., Campbell, A. (Eds.), The Oxford Handbook of Strategy. Volume I: A Strategy Overview and Competitive Strategy. Oxford University Press, Oxford, pp. 132–166.
Teece, D.J., 2006. Reflections on profiting from Innovation. Research Policy 35 (8), 1131–1146.
WIPO, 2003. Intellectual Property (IP) Rights and Innovation in Small and Medium-sized Enterprises, World Intellectual Property Organization (WIPO), Retrieved from http://www.wipo.int/export/sites/www/sme/en/documents/pdf/iprs_innovation.pdf (accessed 2.07.10).
WIPO (2004). WIPO Intellectual Property Handbook: Policy, Law and Use. World Intellectual Property Organization, Publication No.489. Retrieved from http://www.wipo.int/export/sites/www/about-ip/en/iprm/pdf/ch2.pdf (accessed 29.07.10).
Wynarczyk, P., Watson, R., Storey, D., Short, H., Keasey, K., 1993. Managerial Labour Markets in Small and Medium-sized Enterprises. Routledge, London.