



The Impact of the Patent System on SMEs

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ABSTRACT

The authors consider evidence from a range of sources about the propensity of small and medium-sized enterprises (SMEs) to patent their innovations. Drawing on UK, European and US data sources, they use new analysis to show that small firms are less likely to use patents as a means of protecting their investment than other means such as confidentiality, secrecy or being first to market with a new idea. SMEs are also less likely than larger firms to use others' patents as a source of innovation themselves, preferring conferences and trade journals. Reasons for these differences include the cost of filing patents and of maintaining specialist intellectual property staff. Cost and capacity pressures also explain why small firms license out more of their patents to other firms. In joint research with the Massachusetts Institute of Technology (MIT), the authors find that small firms in the United States are twice as likely as those in the UK to patent innovations, but are still much less likely to do so than larger firms. However, patents are seen as increasingly important factor in investment decisions by venture capitalists, which may influence patenting decisions in the future.

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1 INTRODUCTION

This paper explores the potential role of patents and the patent system in the performance of small and medium-sized enterprises (SMEs) in the economy. We review both the conceptual background to, and the empirical evidence for, the impact of patents on SME behaviour in Europe and the UK. We refer, where appropriate, to evidence from other countries, but our emphasis is essentially within the European domain, with a particular emphasis on the UK.

A number of arguments have been put forward for believing that the role of SMEs in innovation and hence the impact of the patent system upon them, is of particular importance. First, SMEs are claimed to be central to Schumpeterian processes of “creative destruction” – the transformation that comes from radical innovation. There are two parts to this argument. First, SMEs are seen as active innovators, particularly in products of a more radical nature that can threaten the dominant position of existing large firms. In this sense, SMEs should have the greater potential to induce structural change and disrupt the position of incumbent, dominant firms to the ultimate benefit of the consumer. Second, they are regarded as more efficient users of resources in the process of innovation. Whilst there is some evidence to suggest that SMEs may be more efficient innovators than large firms in the sense of generating higher levels of innovative activity for a given level of R&D input, it is also the case that the translation of inventions into substantial competitive advantage may pose problems for smaller businesses. The translation of inventions into large-scale commercially viable business appears to require the superior ability of large firms to appropriate the returns to R&D and execute the transition from original invention and niche market into large market domination. In this sense on average SMEs appear to lag considerably behind larger firms. To the extent that this is a result of the superior ability of large firms to appropriate the value from their innovative activity due to patenting, this would suggest that property rights may be an important factor to consider in distinguishing, in terms of innovation potential, large from small firms.

However, there are important reasons why SMEs appear to make less effective use of patents. First, SMEs reliance on patents as a source of competitive advantage may be hindered by costs that either on average or at the margin are higher than those for large firms. Secondly, the ability to recognise and develop an efficient level of protection through patenting may be hindered in SMEs because they do not have sufficient internal competence to manage effectively

this aspect of their business development. Finally, even where SMEs are able to recognise the importance of patenting and put in place appropriate patents, they may be at a substantial disadvantage in enforcing them. This is particularly likely to be the case with respect to larger firms who not only may have a sufficiently deep pocket to protect their own IP or challenge the IP of SMEs, but may have greater competence at both designing and defending their own patent position against emergent rival patents.

The reliance of SMEs on patents varies greatly by sector in a way which is not directly related to rates of innovative activity per se. Thus firms active in the biotech, pharmaceutical, medical devices sectors and some areas of ICTs display a much higher propensity to patent than firms in other sectors of the economy where other methods of protecting appropriation rights are used such as secrecy or speed to market. The sectoral dimension of the problem also figures prominently, for example, in the recent debate about patenting in software and financial services (with the addition of business methods patents in some countries, including the US). Although the mainstream economic rationale for patents is broadly accepted, the role of strong IPs through patents and their effects on the strategy and performance of SMEs is rather controversial.

This paper compares SMEs with larger firms. In Section 2, we discuss the role of SMEs as innovators. In Section 3, we address the rationale for strong intellectual property protection and the drawbacks. In Section 4, we examine the extent to which SMEs use patents to protect intellectual property rights compared with other forms of IP protection. We report the main findings from the literature but also provide some statistics on the patenting behaviour of UK SMEs drawn from UK Community Innovation Survey data. In Section 5, we present evidence from an original dataset of UK and US firms jointly developed by the Centre for Business Research at the University of Cambridge and the Industrial Performance Center at the Massachusetts Institute of Technology. In examining the trends that emerge from empirical analysis, we discuss in Section 6 where the relationship between the patent systems and SMEs works well in stimulating innovation or improving private and social returns, and where it does not. A short conclusion is offered in Section 7.

2 SMES AS INNOVATORS: THE UK EVIDENCE

It is conventional to define SMEs in terms of employment size and most recently in EU, OECD and other statistics to define SMEs as businesses employing less than 250 employees. Defined in this way, the SME sector still covers a very wide range of firms. Discussion of the role of intellectual property therefore needs to reflect the relative importance of different sizes and types of SME and their role in innovation and research and development (R&D), as well as the various ways in which they may appropriate value from their innovations.

In this section we first of all provide a brief overview of the range of firms' sizes and growth patterns within the SME sector, and their relative importance by industry. We then discuss their role in R&D and their comparative rates of innovative activity.

Table 1 shows that SMEs are a significant part of the economy. There were 4.7 million businesses employing fewer than 250 people in 2008. Within that group, however, 3.5 million firms had no employees: these sole traders or solo directors accounted for around 17% of UK employment, but a much smaller proportion (8%) of turnover. SMEs employing 1-9 people accounted for a further million workers, mainly in businesses employing between one and five people.

Table 1 - Number of enterprises, employment and turnover by number of employees, UK private sector, start of 2008

	Number Enterprises (/000s)	Number Employment (/000s)	Number Turnover¹ (£million)
All enterprises	4,783	23,128	2,994,978
All employers	1,238	19,239	2,763,280
With no employees ²	3,546	3,888	231,698
1-9	1,033	3,857	420,282
10-49	172	3,332	442,396
50-249	27	2,665	406,450
250 or more	6	9,386	1,494,152

170,000 firms employed 10-249 workers, and only 6,000 businesses employed 250 workers or more. Yet these 6,000 firms, as Figure 1 shows, accounted for

¹ "All Industries" turnover figures exclude Section J (financial intermediation) where turnover is not available on a comparable basis.

² "With no employees" comprises sole proprietorships and partnerships comprising only the self-employed owner-manager(s), and companies comprising only an employee director.

49% of all turnover and 41% of employment. They employed nearly as many people as the 1.2 million businesses shown in Table 1 employing 1-250 workers, and had a higher turnover than the 4.5 million enterprises employing fewer than fifty people.

It is also useful to consider the distribution of small and medium-sized enterprises by sector. Small businesses are most prevalent in agriculture, construction, hotels, health and personnel services, and business services. They are less common in manufacturing and the financial sector (BIS, 2009). In our analysis of the use of intellectual property protection, we are therefore careful to disaggregate by sector.

In addition to the differences in size distributions, there are also big differences in growth rates. If we focus on SMEs employing 10-250 employees in the UK in the periods 2002-05 and 2005-08, we can define high growth firms as those which in any period of three years achieved an annualised growth rate of employment or turnover of 20%. On this basis only 5%-6% of UK SMEs meet the criteria in employment growth terms and 9%-13% do so on turnover growth (Anyadike-Danes et al., 2009).

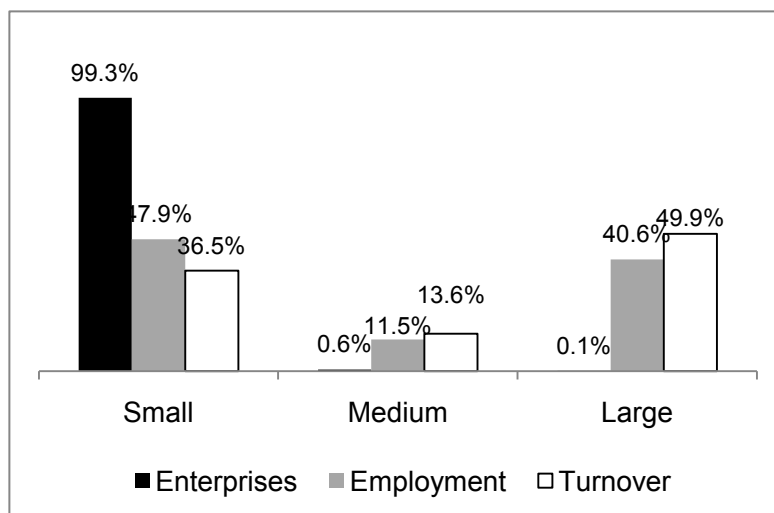


Figure 1 - Share of enterprises, employment and turnover by size of enterprise UK private sector, start of 2008.

Note: Small=0-49 Medium=50-249 Large=250 and over

The share of these high growth firms is greater amongst younger (under 5 years old) than older (5 or more years old) firms, but there are far more older firms in the UK economy, so it is fast growth amongst these that has the greatest turnover and employment impact (Anyadike-Danes et al., 2009). It is important

to note that these fast growing SMEs are to be found in all sectors of the economy and only a small minority are in high technology manufacturing activities. For instance, in the time periods discussed above business services, wholesale and retail firms provide over half the high growth firms whilst manufacturing accounts for only a tenth of those firms (Anyadike-Danes et al., 2009).

We now turn to the role of SMEs in innovation activity in broad terms. One way to look at this is to consider the amount of R&D done by businesses of different sizes. The UK data on R&D also allow a distinction to be made between the R&D undertaken by independent SMEs with fewer than 250 employees and to compare that with R&D activity in the business sector as a whole. In 2005 total UK business enterprise research and development expenditure as a whole was a little over £13 billion. In that year, independent SMEs employing less than 250 workers spent only £454 million on R&D activity. This is 3.3% of total UK business enterprise R&D expenditure. In 2006, moreover, R&D expenditure by SMEs fell somewhat to £356 million (ONS, 2008, Table 26). Even if these figures have a substantial degree of error as they ignore some R&D activity, they still point to the relatively small amount of R&D undertaken by independent SMEs.

Insofar as it is businesses who are conducting this kind of research and development activity who might have most need of an efficiently working intellectual property sector, it is important to bear in mind the relatively small amount of activity which is covered. This is not to deny that there may be important areas of innovation activity not captured by R&D expenditures which may indicate a more significant role for SMEs, or that R&D and patenting may be important in certain specific cases.

Instead of focusing on inputs into the innovation process in the form of R&D, it is also helpful to look at the incidence of innovation outputs. As with the R&D data, it is possible to do this in terms of a distinction between firms employing fewer than 250 people and those employing 250 people or more. The most widely used source of data to provide this sort of information is based on the Community Innovation Survey (CIS). On the basis of the latest published data which relate to CIS4 and cover the period 2002-4, it appears that 23% of businesses which employed less than 250 employees reported that they had introduced a product innovation in the two year period covered by the survey. In relation to process innovation 8% reported that they had introduced such an innovation. It is important to note that the CIS survey does not cover the

smallest firms, so that these results relate to businesses employing between 20 and 250 employees. The proportions of innovative firms in this smaller sized category can be compared with those employing more than 250 employees. In this case, we find a much higher rate of innovative activity. Thus, in the case of businesses employing over 250 workers, over 39% reported a product innovation and 14% a process innovation (DTI, 2006). Again, the larger firms proved more innovative.

There are as we have seen many more small enterprises than there are enterprises employing more than 250 workers. It could thus be argued that the percentage of such small businesses reporting innovation activity reflects a very high importance in terms of numbers of businesses when aggregated up to the national level. That is true, but it is equally true, that when the data is aggregated to national level using weights based on the size of the businesses in terms of employment or value added, then once again the predominant position of the larger businesses reasserts itself (DTI, 2006).

Before a more detailed analysis of SMEs innovation and patenting, we briefly review the arguments for patenting by firms generally.

3 WHY SHOULD FIRMS PATENT OR NOT PATENT?

In this section we highlight the main principles of the economics of patents which will serve us later in the discussion of patenting in relation to the activities of SMEs.³

3.1 The economic rationale for patenting

The public good nature of knowledge as an intangible asset (Arrow, 1962) requires the setting up of institutional mechanisms capable of ensuring a reward for inventors for risky investments which may be reduced if others can freely copy a „successful’ innovation and where there are weak or no gains from being first to market. In the absence of such mechanisms, the private returns to R&D would be instantly dissipated if competitors could imitate at zero cost. Patents are one such legal instrument that can protect the appropriation of value from intangible assets. They grant a temporary monopoly on the exploitation of knowledge. They constitute – it is argued with conviction especially in mainstream theory– the ideal incentive to innovate (Friedman et al., 1991).

Patents are granted by the legislator in exchange for detailed information about the invention, which must be novel and original to satisfy the requirements for patent protection.⁴ Patents are not, however, a necessary and sufficient condition for the translation of an invention into a successful commercial innovation. Innovation defined in the Schumpeterian sense as the commercial exploitation of new knowledge or inventions is tied to the market place and successful appropriation of value may require many complementary assets in addition to patent protection per se. Patents are only one of many ways in which firms might seek to appropriate the returns to R&D. Secrecy, speed to market or control of other assets necessary to exploit a patent, may be more important. Finally, patents may be abused to protect or maintain monopoly positions.

Hall (2009) sums up the benefits and costs of patents by distinguishing their effects on competition from their effects on innovation. To grant firms temporary monopolies for proprietary ideas means reducing the level of competition in the sector. The compensating positive effect is that strong IP protection from a patent can help a small firm to enter an industry dominated by

³ Other contributions to the SABIP research project address specifically this problem and we only cover here the main points, later to be related to the behaviour of SMEs

⁴ Again, we leave to parallel contributions the discussion of differences in requirements between patent offices and their nuanced implementations

uninnovative companies. It can also positively affect competition because it renders technologies tradable: this is an important precondition for the existence of technology markets which work on the twin principle that knowledge can change hands and that the best user of an invention is often not its inventor (Gambardella et al. 2007). For innovation, patents are beneficial because they generate an incentive to invest in R&D and thus increase the likelihood of innovation in the economy. They exert a negative effect on innovation in those circumstances where technical progress significantly depends on redeveloping ideas in new ways (recombination), where inventions depend on each other's advances (they are cumulative), and when patents restrict competitive access to the development of challenges to existing dominant positions (Mazzoleni and Nelson, 1998; Bessen and Maskin, 2009).

3.2 Alternative means of appropriability

Patents are not the only instruments firms might use to protect returns to their investment in innovation. A range and combination of strategies can be implemented. Intangible assets, such as intellectual property, certainly have high informational content, but the pool of resources necessary to innovate is much richer. To the extent that information has the characteristics of non-excludable and non-rival use and can be replicated at zero or nearly zero costs, then imitation is easy for competitors. However, knowledge as opposed to information has more fundamentally „sticky’ aspects that make replication difficult and costly, since its development and use in specific contexts may make replication elsewhere costly and inefficient.⁵ Knowledge is also a more layered and complex notion than information and has significant tacit components that can be transferred not through codification but instead through lengthier social processes involving individual and group interaction and learning. These may have a strong localised nature, are typically path-dependent and tend to display patterns of uneven geographical distribution (Antonelli, 2001; Foray 2004). These aspects make the choice of patenting as the innovators’ preferred mode of appropriation of value from knowledge far from obvious, and need to be considered along with a number of other strategic and environmental factors. These factors include, for example, the characteristics of the technology, the complexity of innovation process, the relevant phase of firm growth and industry effects.

⁵ For a recent discussion of these notions in relation to patents, see Encaoua et al. (2006).

Other means of appropriation (ensuring a return) include secrecy, acquisition and exploitation of complementary assets (such as skilled labour or specialist equipment), and the time it takes to bring the product to market. Patents provide the inventor with legal protection but, as public documents, they also reveal to competitors most of the details of any given invention. It is often the case that imitation is still possible without infringing an incumbent innovator's rights: the nature of the technology might make it possible to „invent around' a particular design or technical specification (Mansfield, 1986). From the viewpoint of the inventor, this is a case where secrecy can be a more appropriate means to capture the returns to R&D. This might be especially useful when the nature of the invention is incremental and related to a new process as opposed to a new product. Availability of complementary assets (Teece, 1986) is also crucial for effective commercialisation of innovations and specific strategies of asset acquisition/management need to be in place when firms lack, for example, marketing or production capability, or complementary equipment or licences necessary to gain full economic returns from their investments. Discrete inventions are better suited to patents than to complex and technologically distributed ones (Cohen et. 2000).

Lead-time advantage – being able to beat a competitor to the marketplace - is another way to protect IP; it is often combined with secrecy. Lead-time – or first-mover – advantages stem from the decision to launch a new product or service in the marketplace before any other competitor. It is a risky strategy (the market is „untested') but first-movers can benefit from valuable reputation effects and from cumulative learning processes much earlier than rival firms active along a similar technological trajectory and operating in the same market. First-mover advantages are especially powerful when first-entrants manage to establish a market standard or dominant design early on in the competitive process (Utterback, 1994). Naturally, this kind of IP appropriation strategy, like secrecy or the exploitation of complementary assets, is seldom used in isolation. Patents are often used jointly with non-legal instruments such as design complexity and speed to market a complementary strategy to protect intangible capital (Laursen and Salter, 2005).

3.3 IP and sectoral innovation regimes

A large body of evidence demonstrates that the role of patents varies greatly from sector to sector of the economy. The findings from different innovation surveys are quite consistent on this point. The Yale (1983) and Carnegie

Mellon (1994) surveys, both focused on US manufacturing, show that patents are highly concentrated in a few industries, namely pharmaceutical, biotechnology, medical equipment, chemicals, computers and special purpose machinery.⁶ The returns to patenting relative to the decision not to patent are also only positive for the above sectors (Arora et al., 2003). Patents in these sectors are, moreover, often filed not so much with the aim to protect IP per se (that is with the intention to bring a novel idea to market) but for strategic reasons, including reputation, cross-licensing and bargaining power as main objectives. Furthermore, their effectiveness is related not only to the nature of the knowledge they capture in a codified form, but also the product or process orientation of the invention.

Evidence from European studies does not differ substantially from the US. The MERIT PACE Survey (Arundel et al., 1995) and several iterations of the Community Innovation Surveys provide support for significant effects of sectoral innovation regimes upon firms' IP appropriation strategies.

⁶ See Mansfield (1986).

4 PATENTS AND SMES

4.1 The use of patents for IP appropriation and as an information source

In a much cited study of IP protection strategies in Europe, Arundel (2001) analysed data from the 1993 Community Innovation Survey. Figure 2 shows the percentage of (all-size) respondents that indicated each of the methods (lead-time advantages, secrecy, complexity of innovation, patents and design registration) as the most important strategy. Lead-time is clearly the preferred choice for both product and process innovation, while patents rank second-last among the available options.

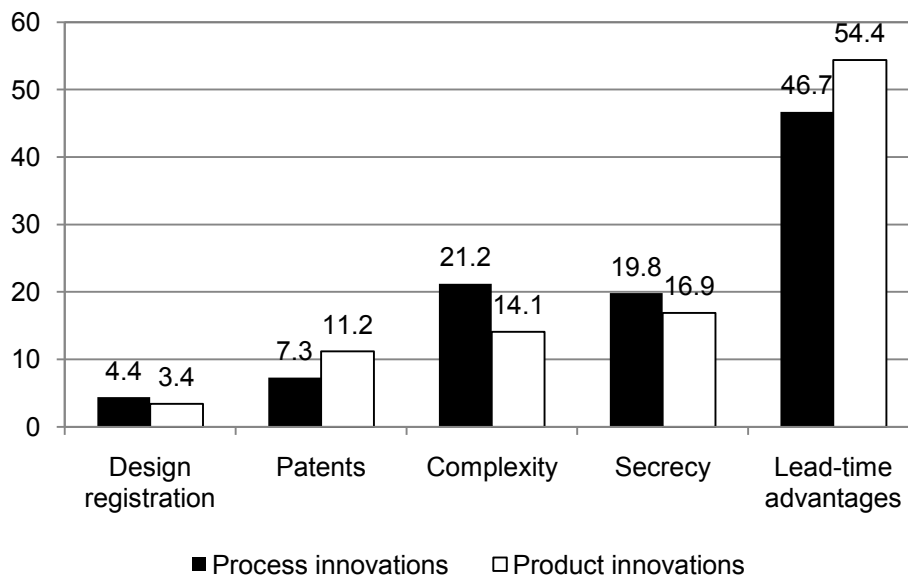


Figure 2 - Percentage of R&D-active firms attributing highest score to different appropriation mechanisms

Source: adapted from Arundel (2001)

When only patents and secrecy are considered, firms' preferences tend to be for secrecy and this pattern is very stable across firm sizes (Table 2). Secrecy is, however, even more important for smaller firms relative to larger ones than patents. The negative association is statistically significant (Arundel, 2001, Table 2 p.60).

Table 2 - Relative importance of patents and secrecy for all R&D-performing firms in 1993 in Europe (% Firms, standard errors in parentheses)

Employees	N	Product innovations			Process innovation		
		Patents more important	Equal importance	Secrecy more important	Patents more important	Equal importance	Secrecy more important
<20	183	17.5 (2.8)	38.3 (3.6)	44.3 (93.7)	10.4 (2.3)	40.4 (3.6)	49.2 (3.7)
20-49	386	17.6 (1.9)	23.6 (2.2)	58.8 (2.5)	12.4 (1.7)	27.5 (2.3)	60.1 (2.5)
50-99	452	23.0 (2.0)	28.5 (2.1)	48.5 (2.4)	11.1 (1.5)	37.4 (2.3)	51.5 (2.4)
100-249	668	20.7 (1.6)	28.0 (1.7)	51.3 (1.9)	11.8 (1.3)	35.9 (1.9)	52.2 (1.9)
250-499	479	20.5 (1.8)	30.1 (2.1)	49.5 (2.3)	12.3 (1.5)	29.6 (2.1)	38.0 (2.3)
500-999	319	24.5 (2.4)	24.8 (2.4)	50.8 (2.8)	9.7 (1.7)	23.2 (2.4)	67.1 (2.6)
1000-1999	186	23.7 (3.1)	33.9 (3.5)	42.5 (3.6)	10.8 (2.3)	30.6 (3.4)	58.6 (3.6)
> 1999	179	30.7 (3.5)	26.1 (3.3)	43.2 (3.7)	19.9 (3.0)	23.3 (3.2)	56.8 (3.7)

Source: Adapted from Arundel (2001)

When firms with high R&D intensity are considered, Arundel (2001) also finds that these high R&D intensive firms have a stronger preference for patents compared to the average of the broader sample of all R&D-performing firms, but secrecy is still scored higher across all firm sizes. Moreover, this data shows that smaller firms are still less likely to use patents and more likely to use secrecy than larger firms.

In an ordered logit multivariate analysis, not reported in detail here, and controlling for other factors that might affect the choice of IP appropriation mechanism, Arundel finds that:

1. R&D intensity loses its predictive power in the choice between secrecy and patents and
2. process innovation-oriented strategies are positively associated with the use of secrecy.

Moreover, firms that rely on in-house information for R&D activities are more likely to use secrecy than patents, but the opposite is true for collaborative

projects, where the use of patents might make IP ownership clearer. Finally, the relative importance of secrecy over patents appears across all sectors.⁷

It thus appears, at least on a univariate basis, that SMEs are less likely than larger firms to use patents and more likely to use secrecy. The patenting firm sees the patent as a good way to protect IP, while a firm accessing other firms' disclosures can see patents as a window into competitors' R&D activities. So, do SMEs use patent documents as sources of information? Again using CIS 1990-92 data Arundel and Steinmueller (1998) show that patents are not a very important source of technical information for SMEs⁸ compared with customers, suppliers, trade fairs, competitors, conferences/journals and public research in that order. For companies that are R&D active patents are even less important than the input of consultants, which is instead relatively more important for SMEs that do perform R&D (SME&R&D in Figure 3).⁹

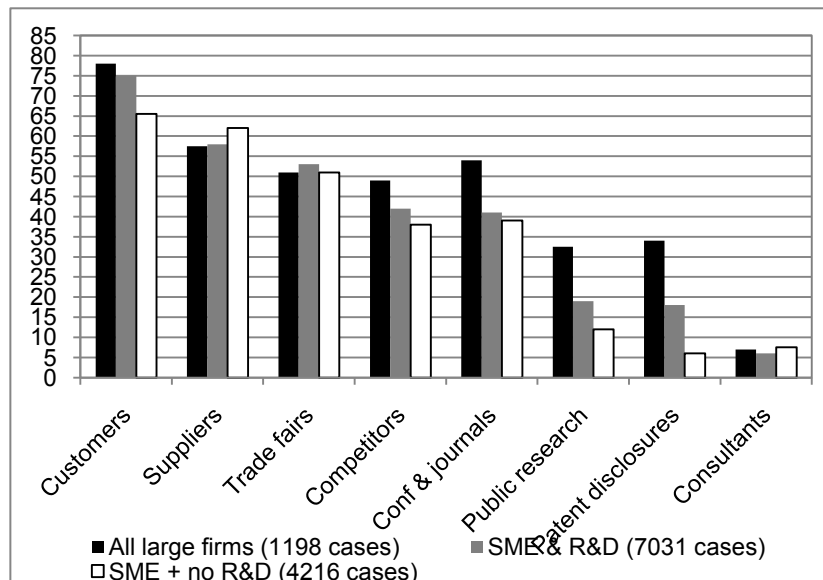


Figure 3 - Importance of information sources for innovation in Europe

(% firms using each source)

Source: Adapted from Arundel and Steinmueller (1998)

Once firms decide to use patenting to protect their IP, there are many ways in which they can use the patent. The PATVAL survey (Giuri et. al 2007) tested

⁷ Unfortunately, the authors do not appear to test explicitly for firm size effects.

⁸ Companies with employment comprised between 10 and 499 people are here classed as SMEs

⁹ The authors also find that overall the reliance of firms on patents as sources of information is sector-dependent.

the results of a number of previous studies that had addressed the use of patents 1) to block potential competitors' activities, 2) to trade technological know-how via licensing or cross-licensing and 3) the choice not to use a patent (Arora et al., 2001; Rivette and Kline, 2000; Cohen et al., 2000; Hall and Ziedonis, 2001; Ziedonis, 2004; Arora and Ceccagnoli, 2006).

The survey, conducted between 2003 and 2004, collected information about 9216 patents filed between 1993 and 1997 in six European countries (Germany, France, the UK, Italy, the Netherlands and Spain). Inventors were asked about the use that was made of the patent in the interval between the time of application and the survey. Overall, the researchers found that patents were (in decreasing order of importance): used for internal industrial and commercial purposes by the company (50.5%); used to block other companies (18.7%); not used but not „blocking' („sleeping' patents: 17.4%); licensed (6.4%); both licensed and internally used by the company (4.0%); used for cross-licensing agreements (3.0%). Interestingly, technology macro-classes (Electrical Engineering, Instruments, Chemicals and Pharmaceutical, Process Engineering, Mechanical Engineering) reflected the general distribution.

Figure 4 shows that there were differences by firm size.

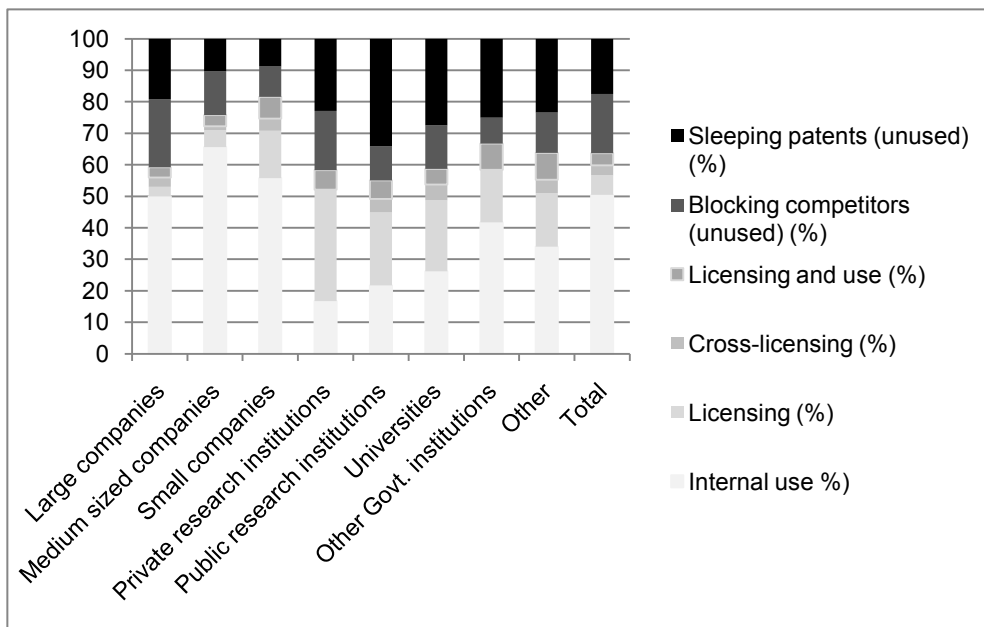


Figure 4 - Use of patents by type of employer in various countries (N=7556)

Data Source: Giuri et al. (2007)

Large firms use 50% of the patents of their survey sample for internal purposes; they license 9.2% of them, employ 21.7% to block rival R&D and do not actively (through commercial development) or passively (by blocking) use the remaining 19.1%. Medium-size firms develop a lot more patents for internal use (65.6%), license a similar percentage to large firms (10.2%) and have less than half the amount of strategic or dormant patents. Small firms exploit 55.8% of their patents internally, less than medium size companies, but a higher proportion than large firms. Smaller firms also license out a relatively high percentage of patents (15.0%). This latter finding is also corroborated by a parallel analysis of the same data (Gambardella et al. 2007) that shows firm size is the single most important determinant of the decision to license out technology and is negatively related to it. Finally, in Figure 4, smaller firms report very few unused patents (9.6% of blocking patents and 8.8 % of dormant inventions).

Taken together, these results are consistent with smaller firms licensing out more in pursuit of the complementary assets necessary to develop and appropriate value. They are also consistent with an inability or reluctance to maintain sleeping or dormant patents because of the relatively high fixed costs which SMEs may be unwilling or unable to bear. SMEs may thus patent more viable intellectual property.

4.2 The UK evidence

In this section, we focus on the UK economy. Rogers et al. (2007a and 2007b) conducted two related studies of the characteristics of SMEs that use IP appropriation methods. These analyses are based on a data set matching FAME¹⁰ records with UK and European patents and with Marquesa Ltd data on UK and European trademarks. The definition of SMEs in this study is based on firms' total assets rather than employee numbers. Firms are classified as large when their total assets exceed £28.7 million, as SMEs when this figure is between £1.3 and £28.7 million, and as microfirms when asset value is £1.3 million or less. We then present some independent analyses of CIS4 data on the patenting behaviour of UK firms, where the definition of SMEs is instead based on employment groups.

Using the FAME data it appears that the number of UK patent publications by all UK registered firms fell between 2001 and 2005 from 4,272 to 3,709, although this is likely to be due to incompleteness of 2005 data. Over the same

¹⁰ FAME is a database providing intelligence on UK and Irish companies

period, the number of European Patent Office (EPO) patents did not change significantly, remaining around 4,000 units (Rogers et al. 2007a). Disaggregation of patent publications by firm size shows a decrease in large firms using UK patents and minor increases¹¹ in the number of combined publications by SMEs and microfirms; indeed, their combined contribution matches or exceeds that of large firms (Figure 5).

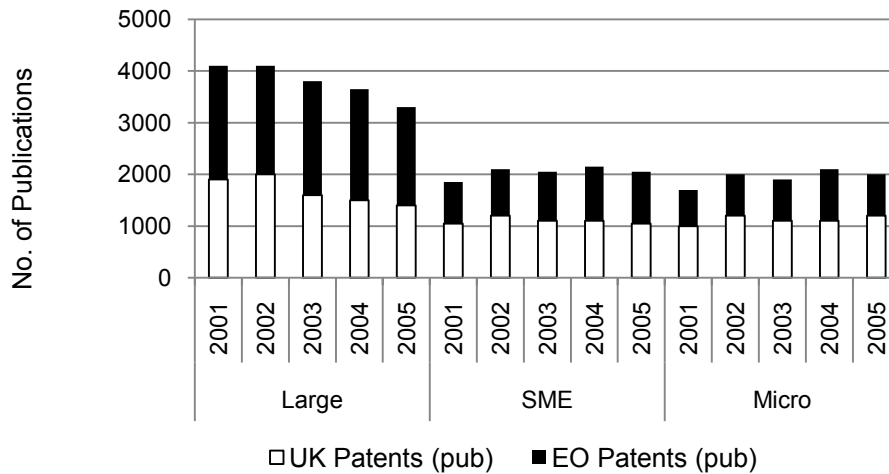


Figure 5 - Numbers of patents by firm size 2001-2005

Source: Rogers et al. (2007a)

The same study finds a slight decrease over time in the number of large firms using UK patents, though no reduction in EPO patents. SMEs and microfirms seems to be increasingly active, although the number of patents per firm remains on average well below that of larger firms. The majority of patents are published by SMEs in the following regions, in decreasing order of importance: South East, Greater London and East Midlands.¹² Moreover, SMEs are less inclined than large firms (and also microfirms) to patent jointly with other firms, but are more likely to co-patent with universities. Micro firms are by far the most likely to file joint patents with universities

(Rogers et. al, 2007a).

The sectoral distribution of patenting is very uneven. Patenting is strongest in manufacturing. According to Rogers et al. (2007a), this sector accounts for

¹¹ Excluding 2005 where data is incomplete

¹² The geographical distribution of patents is arguably dependent on the distribution of the broader UK economic activities and on the sectoral patterns of industry localisation

1,734 out of a total of 3,101 UK patenting firms and 1,202 out of a total of 2,423 firms with EPO patents (2001-2005). The next best performing sectors by EPO patents are, in order of importance, R&D services (372), business services (262) and computer-related activities (151). Table 3 reports extracts from the same data at the more precise 2-digit SIC level of aggregation. The majority of UK patenting firms, with some differences in relative rankings, are found in the following sectors: fabricated metal products, furniture and manufacture, machinery and equipment, chemicals and chemical, rubber and plastic, and medical and optical instruments (Table 3).

Table 3 - Number of patenting SMEs and average publications in UK manufacturing industries 2001-2005

Manufacturing industry	UK Pat	Av	EPO patent	Av
Food and Beverages	10	1.5	12	1.3
Tobacco Products	1	1.0	1	2.0
Textiles	21	1.2	18	1.1
Wearing Apparel	6	2.0	4	1.0
Tanning & Dress, of Leather	1	1.0	1	1.0
Wood and Products of Wood	12	1.6	1	1.0
Pulp Paper and Paper Prod.	23	1.1	14	1.1
Publishing and Printing	44	1.4	34	1.5
Coke and Refined Petroleum	2	1.0	1	1.0
Chemicals and Chemical	107	1.4	158	1.8
Rubber and Plastic Prod.	131	1.5	79	1.4
Other Non-Metallic Minerals	30	1.7	11	1.5
Basic Metals	26	1.3	6	1.2
Fabricated Metal Products	337	1.5	179	1.4
Machinery and Equipment	211	1.5	155	1.4
Office Machines and Compu.	33	2.6	16	2.0
Electrical Machinery	159	1.6	112	1.6
Television and Line Telecom.	94	2.4	81	4.0
Medical and Optical Instruments	168	1.8	154	1.6
Motor Vehicles	33	1.8	21	1.4
Other Transport Equipment	15	1.2	6	1.0
Furniture Manufacture	278	1.3	149	1.3

Source: Adapted from Rogers et al. (2007a)

Large firms active in patenting or trademarking seem to be more profitable than non-IP active firms, though the same is not true for SMEs or microfirms. The former have lower profitability, the latter negative profitability, compared with non-IP active counterparts (Rogers et al., 2007). This is a likely consequence

of the risky nature of R&D investments, the smaller product portfolio of smaller firms and the phase of growth of the firm, where profits are likely to be generated some time after the initial layout of R&D and other start-up or early growth costs. For the same reasons, IP-active SMEs are at higher risk of liquidation or receivership than IP-inactive SMEs when they exit the market, though the percentage of IP-active firms that exit the market is slightly lower than among IP-inactive firms. However, there is no significant relation between IP activity and the probability of exit (except with joint patenting). Evidence of the effects of IP on growth is mixed, being more polarised towards very good and very poor performance than IP-inactive SMEs. A similar polarisation effect is reported in the analysis of the effects of IP on profitability (Rogers et al., 2007b).

Finally, they report lower financial returns than other firms. It thus appears that UK SMEs (on this asset based definition) are in keeping with international studies, less likely to be patenting. They are concentrated in a narrow range of manufacturing in clusters and are more likely located in the South East Greater London and the Midlands and more likely than large firms to co-patent with inventors.

Analyses conducted by the Centre for Business Research (CBR) at Cambridge University on CIS4 data from the fourth round of the Community Innovation Survey address the question of SMEs' propensity to patent vis-à-vis other means of IP appropriation and its sector-specific trends with a specific focus on the UK. Figure 6 charts the responses by large and small firms to a question about their perceived sources of profits (introduction of innovated products or services in the market place, design, training, acquisition of external knowledge, acquisition of machinery, software or equipment, outsourcing of R&D, in-house R&D). In these calculations we have defined small firms are those with 1-99 employees, medium are 100-999 and large are equal or above 1,000. These classifications are more comparable with the FAME based size classification reported earlier. The percentage of large firms is higher than that of SMEs for each factor, with figures that are most similar for the acquisition of machinery, software and equipment and most different for the acquisition of R&D, with a two-to-one ratio. SMEs in general thus appear less likely to be generating appropriable profits from technology and innovation related sources.

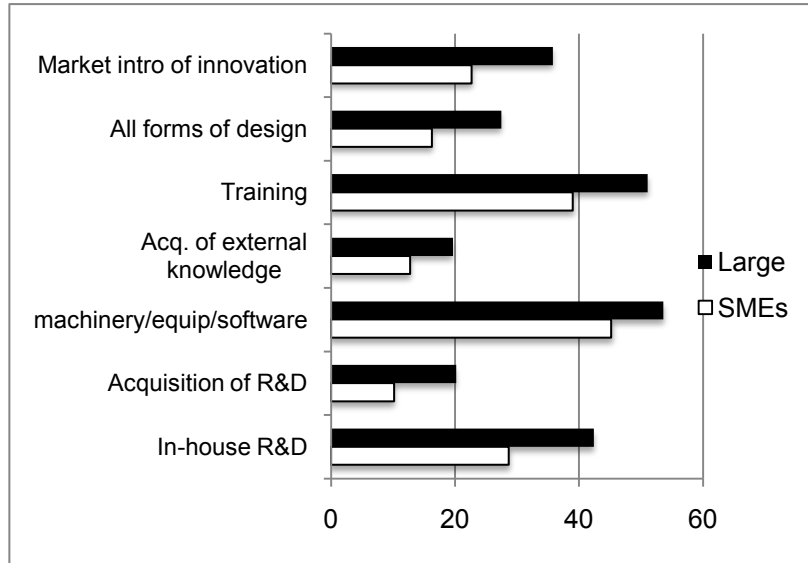


Figure 6 - Perceived sources of profits, UK CIS-4, large firms and SMEs 2002-4 (% Firms)

Source: Calculated from CIS4 data

If we turn to the use of IP as an appropriation method Table 4 shows results consistent with Arundel's (2001) findings for an earlier period for the EU. Patents are the third least preferred appropriation mechanism among SMEs, with only design complexity and registration of design scoring lower. In the sub-sample of R&D-performing SMEs, patents score better, but still lag behind confidentiality agreements, lead-time advantages and secrecy (Table 4). Table 5 shows patents are more important for product than for process innovations – and this is true regardless of whether firms have R&D capacity.

Table 4 - Importance of protection method for all firms and for R&D performing firms in the UK 2002-4

Protection methods	% of enterprises for whom the method is of high importance		% of R&D-performing enterprises (Activities=1) for whom the method is of high importance	
	SMEs	Large	SMEs	Large
Registration of design	4.9	10.5	7.3	14.2
Trademarks	6.8	15.3	9.8	19.6
Patents	6	12.9	9.1	17.3
Confidentiality agreements	11.7	21.6	17.3	27.9
Copyright	6.1	9.9	9	12.7
Secrecy	9.3	18.1	13.8	23.4
Complexity of design	5.2	8.9	8	11.7
Lead-time advantage	10.4	16.5	15.6	21.8

Source: Calculated from CIS4 data

Table 5 - Importance of protection method for product and process innovation in the UK 2002-4

Protection methods	% of SMEs for whom the method is of high importance		% of R&D-performing SMEs for whom the method is of high imp.	
	Product innov.	Process innov.	Product innov.	Process innov.
Registration of design	10.6	9.5	10.9	9.6
Trademarks	14.2	12.1	14.7	12.1
Patents	14.1	12.9	14.8	13
Confidentiality agreements	25.8	26.8	26.6	26.8
Copyright	13.3	12.4	13.8	12.5
Secrecy	19.9	20	20.6	20
Complexity of design	13	12.7	13.5	12.7
Lead-time advantage	23.1	23.6	23.9	23.6

Source: Calculated from CIS4 data

We can check for cross-sectoral effects by comparing high-tech manufacturing and business services sectors. Thus, in Figure 7, we disaggregate the data by classes of technology intensity and distinguish high-tech from conventional manufacturing and high-tech business services from other services. In the high-tech manufacturing group, 47.9% of small firms and 74.1% of medium-size firms report relying on patents to protect IP against 37.3% and 61.6% respectively in the conventional manufacturing group. Lead-time advantages

(82.2% and 90.4%), secrecy (75.3% and 89.6%) and confidentiality agreements (79.1% and 88.1%) are especially important for high-tech manufacturing SMEs. Nevertheless, patents gain in importance relative to R&D intensity for high-tech manufacturing firms (Figure 8). These CIS4 results taken as a whole are broadly in line with our earlier review of international studies and the UK study based on FAME data.

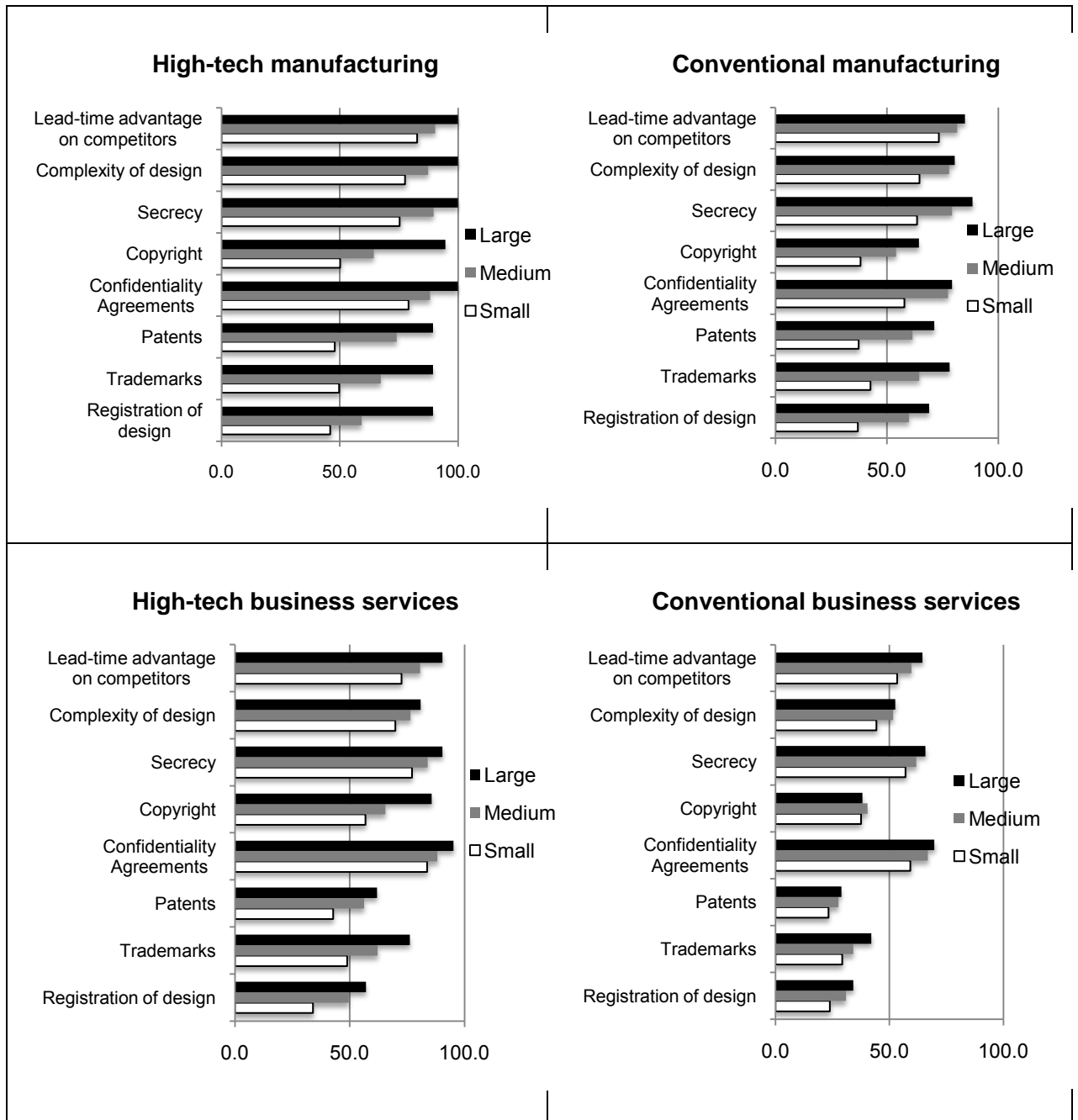


Figure 7 - Percentage of innovators using each IP appropriation strategy in the UK 2002-4

Source: Calculated from CIS4 data

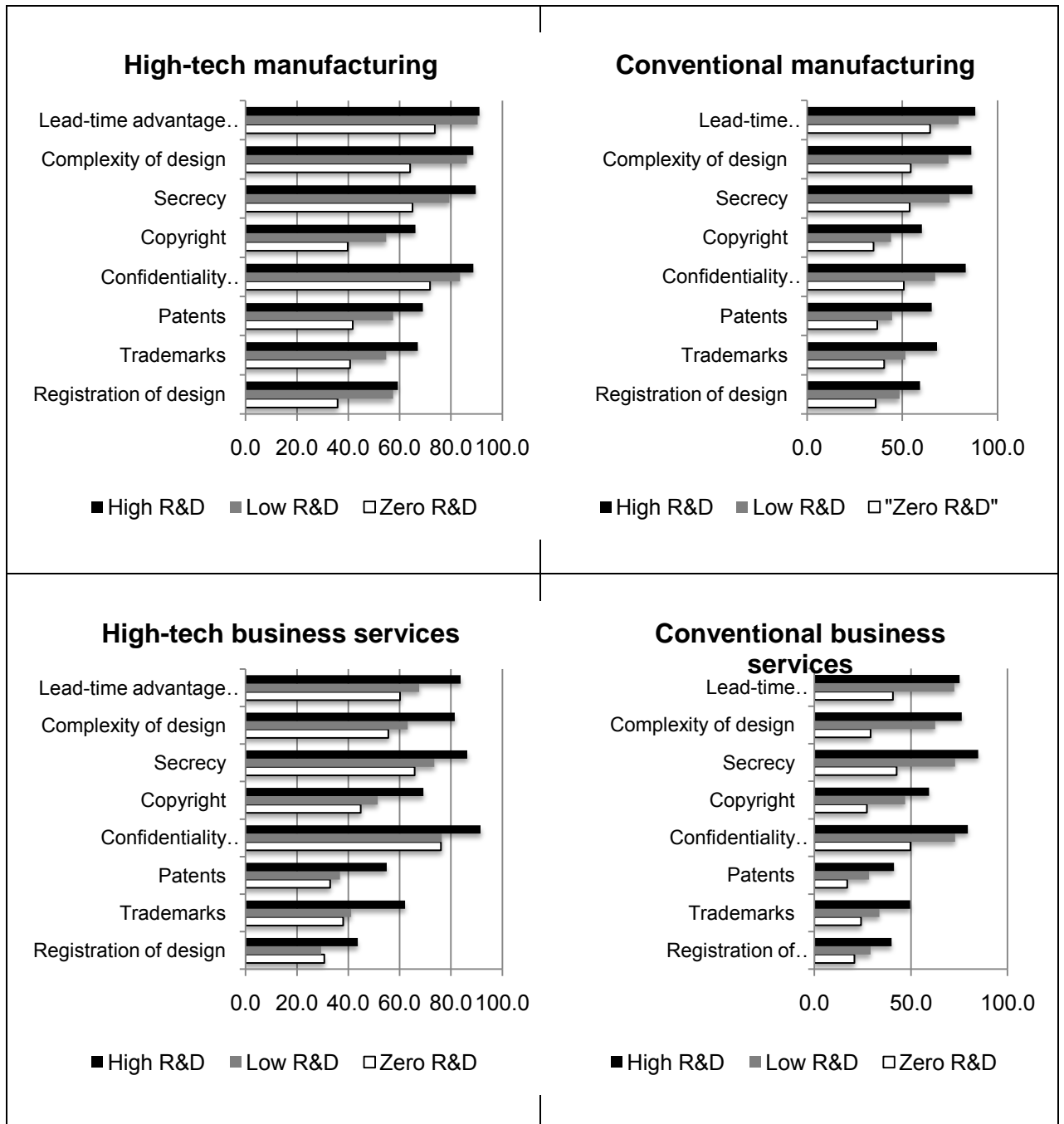


Figure 8 - Percentage of innovators using IP protection by R&D intensity in the UK 2002-4

Source: Calculated from CIS4 data

5 INNOVATIVE SMES AND THE PROTECTION OF IP IN THE UK AND THE USA

So far we have considered innovation activity across Europe and in the UK. In this section we compare the UK and the USA using a unique dataset prepared in a collaborative project between the CBR at Cambridge and the Industrial Performance Center at MIT (for full details of the underlying project and survey see Cosh, Hughes and Lester (2006) and Cosh and Hughes (2010)). The survey covered manufacturing and business services: the results reported here relate to small firms defined as those employing between 10 and 99 employees in the UK and the USA in 2004-5. The results are based on a sample of these small firms drawn from a size- and industry-matched sample of around 900 businesses in each country reporting innovative activity in the previous three years. The full sample showed the same variations between small and large firms in both countries on the acquisition of patents and licences, patenting activity and the use of various protection methods that we have seen in our earlier analyses. We therefore focus only on the results for the smaller businesses in this section.

We begin by looking at the extent to which innovative small businesses in the UK and the US engage in the acquisition of patents and licences. As Table 6 shows, the vast majority of innovative small firms never engage in this activity. If anything, the proportion never doing it is higher in the US than in the UK. Around 29% occasionally engage in this form of activity in the UK compared to 21.8% in the US, whereas in both countries only around 7% do so continuously.

Table 6 - Frequency of engaging in: Acquisition of patents & licences (Innovators only)

	Never	Occasionally	Continuously	Total
UK: 10-99	63.8	29.0	7.2	100
US: 10-99	70.6	21.8	7.6	100

Source: Calculated from CBR/IPC international innovation benchmarking dataset

On the related question about the extent to which firms engage in the purchase of specialised patenting advice and training services, we find a similar pattern in both countries: such activities are only occasionally accessed by smaller innovative businesses.

Table 7 - Frequency of engaging in: Purchase of specialised (Non R&D) services from outside such as patenting advice, training (Innovators only)

	Never	Occasionally	Continuously	Total
UK: 10-99	43.6	46.9	9.5	100
US: 10-99	41.9	49.3	8.8	100

Source: Calculated from CBR/IPC international innovation benchmarking dataset

So far we have considered only the frequency of activity. A rather different picture emerges if instead we look at the percentage in total innovation related expenditure spent on acquisitions of patents and licences. It appears that in this case small US firms, although somewhat less likely to be engaged in this activity than small UK firms, nonetheless spend somewhat more. This is also true in the case of the large firms.

Table 8 - Percentage of total innovation-related expenditure in the last financial year spent on acquisitions of patents and licenses (Innovators only)

Size	UK	US
1-99	0.9	1.4
100-999	2.8	1.5
1000+	2.0	3.6

Source: Calculated from CBR/IPC international innovation benchmarking dataset

We can now turn to the relative importance of different methods of protection in use in innovative SMEs in the UK and the US. Figure 9 presents some data on this which shows the percentage of businesses in the matched sample rating each method of protection that we have looked at in previous sections as important or highly important. These results are not directly comparable with those in earlier sections, because this set of results focuses on a matched sample of innovating small firms only. However, it is striking that in this group, where US companies use a method of protection, they are more likely to rate it as highly important. , UK firms are much less likely to regard patenting as highly important than their US counterparts. There are also substantial differences in terms of trade marks and design.

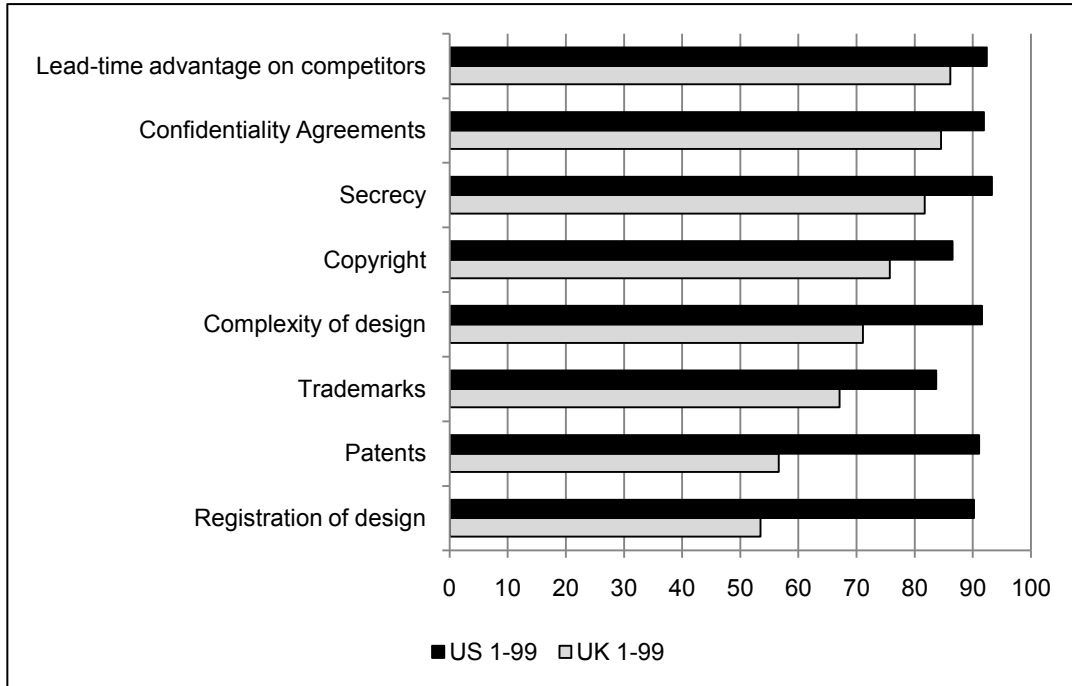


Figure 9 - Methods of protection: innovative SMEs of the UK and the US (% users rating it as important or highly important)

Source: Calculated from CBR/IPC international innovation benchmarking dataset

Finally, Table 9 shows that the relatively low value placed on patents as an important source of protection in the UK is also reflected in the relatively low number of patents granted to firms in the matched innovative sample in the last three years. US firms are much more frequent patenters. In the case of innovative small firms on average twice as many patents are granted in the US as in the UK, although the number is only around 1 patent every three years. For the larger firms, the average number of patents in the US was over 48 in this period compared to fewer than 20 in the UK.

Table 9 - Number of patents firm granted in last 3 years (Innovators only)

Size	UK	US
1-99	0.7	1.3
100-999	2.2	5.1
1000+	19.7	48.1

Source: Calculated from CBR/IPC international innovation benchmarking dataset

The relatively low value placed on patenting in matched samples of smaller businesses in the US and the relatively low level of patenting activity are interesting differences and merit further investigation. We discuss some possible factors in the next section.

6 THE FUNCTIONS OF PATENTS AND THE ROLE OF THE PATENTING SYSTEM FOR SMES: OVERVIEW

We have argued that patents may serve a variety of purposes. The vast majority of research has focused on the protection of innovation-related intangible assets (such as knowledge and skills). This function captures the role of patents in contributing to the innovation performance of firms. Our evidence suggests that firms prefer other means of protection to patents as a means to construct and protect proprietary know-how. Despite the emphasis on patents in the economic literature and policy debate, secrecy and lead-time advantages seem to be much more important for firms, especially SMEs. The sectoral dimension is, however, important, and the number of sectors where patents are necessary to generate and sustain firms' competitive advantage are few and concentrated in high-tech and science-based markets.

Patents are also detailed sources of information. They have the capacity to disclose and disseminate know-how about competitors' state-of-the-art products and processes. Patents could in principle be used as learning inputs by firms seeking to monitor or imitate their competitors' innovations. However, this does not appear to be especially important in practice, least of all to SMEs. (Increasingly easy access to online resources might be making this function of patents more important, though this has not yet emerged in the literature.)

Firms appear to have good incentives to patent for strategic reasons. Patenting in telecommunications equipment or semiconductor industries is often motivated by the strategic objective of blocking competitors' R&D activities and creating a position of advantage in eventual negotiations for IP ownership or use (Cohen et al. 2000; Hall and Ziedonis, 2004). The findings of the PATVAL survey reported in Section 4 provide a recent interesting quantification to this phenomenon in Europe: small firms make relatively little use of blocking patents, probably yet another sign of their higher marginal costs of patenting with respect to larger firms.

Finally, there is an emerging strand of empirical research, building on Mazzoleni and Nelson (1998), according to which firms, especially SMEs, use patents to signal their growth prospects to potential investors. They increasingly take patents as an important determinant in the selection of portfolio choices. Lerner

(2004), for example, showed that patents generally have a positive impact on company valuation. This effect seems to be particularly important for smaller firms. It is perhaps this phenomenon that captures a strong, and often neglected, effect of the patenting system on how SMEs operate. In a recent study on the ability of new firms to attract venture capital investment, Haeussler et al. (2009) find that patents work as risk-reducing signals for potential investors. Their results, based on a study of the German and British biotech sectors, show that the presence of a patent application accelerates VC investment because investors explicitly consider information that is generated through the patenting process as very valuable to their decision. Again, this effect of the patenting system is arguably strongest in specific high-tech sectors.¹³ This is certainly an area where further investigation is needed.

Overall, the role of patents as economic incentives to innovate by protecting the returns to R&D, disseminating information, defending competitive advantage or signalling value, also depends on the quality of enforcement mechanisms. From the viewpoint of SMEs the costs of IP enforcement quite clearly works against the use of patents.¹⁴ Moreover, infringements are a significant problem especially for SMEs. Two separate studies by Rodwell et al. (2007) and Kingston (2004) highlight the extent of the problem and report that the vast majority of European SMEs (75 and 67 percent respectively) had experienced some form of IP abuse in the form, for example, of counterfeiting. These figures might be affected by sizable response selection biases (and the sample for the 2007 study was also rather small), but do nevertheless provide some evidence on the problem.

In some cases, instances of infringement go to litigation. Although data on litigation are rare and patchy there is some relevant literature showing that:

1. the number of cases depends on the costs of litigation relative to the size of the market. The UK has high litigation costs and a low level of litigation compared to the US, Germany, France and the Netherlands (Mejer and van Pottelsberghe des la Potterie, 2009);
2. litigation rates vary significantly by sector and firm size. SMEs, which tend to have smaller patent portfolios, are more vulnerable to litigation

¹³ Another sector where this effect is found is semiconductors (Hsu and Hall, 2008).

¹⁴ For an extensive review of this topic, a recent SABIP report provides good coverage of the relevant literature (Webster et al., 2009).

and tend to be sued by, as opposed to sue, larger firms¹⁵ (Lanjouw and Schankerman, 2004, Ball and Kesan 2009, among others). This is probably because of their inferior bargaining power, information asymmetries about the IP process, or the higher marginal value they attach to their patents. That said SMEs may have some bargaining power that can be used to settle disputes with large firms out of court.

The number of patent applications is increasing and concerns have been expressed about negative trends in their quality, which is not unrelated to strategic uses of patents. The number of litigation cases is also increasing and patent offices are under pressure to adapt to these trends. Harhoff (2009: p. 17) observes:

A badly designed litigation system may encourage extortionary practices, again counteracting the intended positive effects of IPRs. The best IPR court and litigation system should resolve cases fast and at low cost; it should create as few opportunities as possible for influencing rivals' costs of litigation (e.g. by use of mechanisms like discovery of evidence); it should seek to bring the required expertise (in many cases that means technical knowledge) into the judges' chambers; and its cost allocation rules need to lower the risk that frivolous litigation is instigated by cash-rich parties against financially less well-off opponents.

This is as true for the European patent and litigation system as it is for national systems, including the UK. On average, the costs of applying for a patent in the European area are between three and five times higher than in the US and Japan. A solution to this, as Harhoff again clearly points out, is not only to reduce costs but also and above all to create a quality-oriented system on the principle that innovation does not need stronger patents but rather an IP system that gives good protection to high quality inventions in a cost-effective manner.¹⁶

Critics of the current patent systems complain that they are unsympathetic to the needs of SMEs. This is because they are modelled on the characteristics of a few sectors – epitomised by the pharmaceutical innovation model – that are

¹⁵ Although Lanjouw and Schankerman's study for the US (2004) find that they are not disadvantaged as far as litigation outcomes are concerned.

¹⁶ In relation to the observed differences between US and UK SMEs, other factors may play a role that have not yet been properly investigated in the literature: these include differences in the grace period, different incentives in phases of IP application or enforcement, and different levels of competences in gaining, managing and evaluating patents in the respective innovation systems and clusters

not representative of the innovation dynamics of the rest of the economy and of the vast majority of SMEs (MacDonald, 2004). The Gowers report (2005) addressed some of the problems in the UK system and made recommendations for incremental change. The report suggested, for example, improvements in the information infrastructures that could help SMEs to overcome their resource constraints and intensify their IP protection activities. To reduce the costs of litigation, it also recommended the use of fast-track litigation with clear limits on fees, disclosure and duration of the proceedings. It also pointed to the advantages of harmonised European action through the Community Patent, a European Patent Litigation Agreement and a specialised European Court for international cases.¹⁷ Concerns have, however, emerged from the UK SMEs entrepreneurial community that significant problems remain and need attention. Although evidence is anecdotal and unsystematic, the structure of cost and fee repayments, the contestability of granted IP and the provision of independent expert advice in Court are three points where further research and appropriate action might be required.

¹⁷ These recommendations, as well the broader terms of the enforcement problem, are addressed in more detail in the recent SABIP report on „IP Enforcement in the UK and Beyond: A Literature Review’ by Weatherall et al. (2009).

7 CONCLUSION

We have discussed the rationale for SME patenting behaviour. We considered a variety of views on the role of patents in innovation and the arguments for and against expecting patenting by SMEs, their preferences and behaviours, and the sector-specific distribution of their patenting activity. We also discussed the functions of patents in supporting innovation, providing information, business strategy and sending signals to investors. We reported evidence from a number of different surveys, provided some new statistics on the innovation strategies and practices of UK SMEs based on UK Community Innovation Survey data. We concluded by considering the functions of and emerging challenges for the patent system.

The interpretation of the data we have reviewed is consistent with some potentially adverse effects of the IP system on SMEs which could discourage them from patenting. There are, however, no studies which systematically address the role of the costs and benefits of IP protection for UK SMEs on a multivariate basis which could clearly distinguish this effect from other factors, such as lack of internal capability to recognise or exploit patents, or otherwise reduce the commercial appropriateness of using patents as part of their business model. Thus, the relative impact of the specific features of the UK system compared to other factors determining the choice of IP versus other methods of developing and appropriating value remains an important area for future empirical study.

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