
An analysis of the characteristics of small and medium enterprises that use intellectual property

Mark Rogers*, **Christian Helmers**** and **Christine Greenhalgh*****

* Harris Manchester College, Oxford University and Oxford Intellectual Property Research Centre

** Wolfson College, Oxford University

*** St. Peter's College, Oxford University and Oxford Intellectual Property Research Centre

October 2007

Contact: Mark Rogers, Harris Manchester College, Mansfield Road, Oxford, OX1 3TD Tel: 01865 271 018 Fax: 01865 271 012

mark.rogers@hmc.ox.ac.uk

Contents

Summary.....	4
1. Introduction.....	5
1.1. Background.....	7
2. Matching methodology	10
3. Trends in IP activity	11
4. The characteristics of IP active firms.....	18
4.1. Age of firm.....	18
4.2. Industry	20
4.3. Geographical location	24
4.4. Multiple IP activities	27
4.5. Joint patent applications	30
4.6. Patent applicant links with universities.....	31
4.7. Profitability.....	32
5. Propensity to use IP by firm size.....	36
6. Conclusions.....	39
Appendix 1 Industry data.....	43
Appendix 2 Comparisons with UK Community Innovation Survey (2005)	44
Appendix 3 Brief explanation of IP types.....	47

List of Figures

Figure 1	Total numbers of publications (by year)	12
Figure 2	Numbers of patents (by year and firm size)	13
Figure 3	Numbers of patents by foreign-owned firms (by year and size)	13
Figure 4	Numbers of patents by domestic owned firms (by year and size)	14
Figure 5	Numbers of trade marks (by year and size)	15
Figure 6	Numbers of firms that patent (by year and size)	16
Figure 7	Numbers of firms that trade mark (by year and size)	17
Figure 8	Incorporation year of patent active SMEs vs. all SMEs (2004).....	18
Figure 9	Incorporation year of trade mark active SMEs vs. all SMEs (2004).....	19
Figure 10	Number of patents published by region (SMEs only, 2001-2005)	24
Figure 11	Number of patents published by foreign owned SMEs (2001-2005).....	25
Figure 12	Number of trade marks by region (SMEs only, 2001-2005).....	26
Figure 13	UK and Community trade marks for SMEs (2001 – 2005)	29
Figure 14	UK and EPO patents by SMEs (2001 – 2005)	30
Figure 15	Profitability of IP active SMEs compared to IP inactive SMEs.....	34
Figure 16	Profitability of IP active SMEs by IP type.....	35
Figure 17	Liquidity ratio of IP active SMEs and all FAME SME (2001 to 2005).....	36

List of Tables

Table 1	UK companies in FAME database (2005)	8
Table 2	Coverage of SMEs in FAME and IP active SMEs (2001-2005).....	10
Table 3	Benchmarking the matching outcome (number of publications in 2003).....	11
Table 4	Age of SME and IP activity (for 2004).....	20
Table 5	IP active SMEs and average publications (by sector, 2001-2005)	21
Table 6	IP active SMEs and average publications (manufacturing, 2001-2005).....	23
Table 7	Ratio of SME to large firm IP by region (for 2001-2005)	27
Table 8	Number of EPO patents that have priority from UK patent (estimates)	28
Table 9	Percentage of cases when firms involved in joint patenting (2001-2004)	31
Table 10	Proportion of patents made jointly with universities (2001-2005).....	32
Table 11	Median profitability of IP active firms by size (2001-2005).....	33
Table 12	Median IP intensity of firms of different size (2001 to 2005)	37
Table 13	Regressions of IP intensity (2001 to 2005).....	38
Table 14	IP active SMEs and average publications (non-manufacturing, 2001-2005)	43
Table 15	Community Innovation Survey data on rates of innovation and IP use.....	45

Summary

This report documents the creation of a major new database that links IP activity to all UK firms. The database – called the Oxford Firm Level Intellectual Property (OFLIP) database – uses data on all UK firms over the period 2001 to 2005 and matches data on UK patents, EPO patents, UK trade marks and Community trade marks to these firms.

This report then analyses the characteristics of IP active firms, with a specific focus on SMEs. It provides a series of new results that are only possible with this type of database.

A summary of key findings is contained in the Conclusion.

This report is one of two completed in October 2007. The companion report looks at IP usage and subsequent performance and is entitled “An analysis of the association between the use of intellectual property by UK SMEs and subsequent performance”.

The research project leading to these reports was led by Dr Mark Rogers, with assistance from Dr Christine Greenhalgh and Christian Helmers. The research project was funded by the UK Intellectual Property Office and UKTI.

Copies of the reports can be accessed at:

<http://users.ox.ac.uk/~manc0346/>

or by e-mailing: mark.rogers@hmc.ox.ac.uk

October 2007

1. Introduction

There is an ongoing interest in the role of small and medium enterprises (SMEs) in the economy. In particular, understanding how SMEs innovate is of paramount importance in any long run analysis of the performance of the economy. The SMEs of today that innovate – meaning introduce new products, processes or open up new markets – may go on to create the successful, large firms of tomorrow. Put another way, to understand the performance of the UK economy today, we need to understand how SMEs performed 5, 10 and more years ago.

As an example, recent work on business expenditure on R&D (BERD) in the UK suggests that the low BERD to GDP ratio is partly due to the lack of large firms in high R&D intensity sectors, rather than those firms that do exist spending too little on R&D (e.g. DTI, 2005). This, in turn, suggests a failure to grow and sustain large high-tech firms, something that is linked to the performance of SMEs in previous years.

The use of Intellectual Property (IP) by firms is commonly used as an indicator of innovation. It is also often an integral part of the process of turning innovation into commercial success. The Gowers Review of Intellectual Property, which reported in December 2006, was charged with examining the way in which businesses and other organisations use IP, including their importance to businesses across different sectors. Another part of their remit was to explore how well businesses are able to challenge and enforce IP.¹ Without access to enforcement at reasonable cost the incentive to use the IP system falls. However, at the time of their review, there was no wide ranging study available demonstrating the use of IP by SMEs in all sectors.

This report analyses the link between IP activity in the 2001-2005 period and firm-level characteristics, such as geographical location, industry, size and profitability. The report also analyses trends in IP activity over the 2001-2005 period. In this report, IP activity is defined as when a firm has one or more of the following: a UK patent publication, EPO patent publication, UK trade mark publication or Community trade mark registration.² This research project has created a new database of the IP activity of all UK registered firms. This was done by tracking the IP activity of every firm in the Financial Analysis Made Easy (FAME) database. FAME contains details of around 3 million firms, which is the complete population of British registered firms (FAME data is taken from

¹ See the UK HM Treasury website for the scope of the Gowers Review: http://www.hm-treasury.gov.uk/independent_reviews/gowers_review_intellectual_property/gowersreview_scope.cfm

² We are unable to document the use of copyright due to the lack of registration of this type of IP asset. US patent office publications were not included in the scope of this research.

Companies House). The following section gives more details of how the data was created. The remit of the research project was to focus on SMEs, nevertheless we felt it important to collate information on the IP activity of micro and large firms. This allows a comparison of the three firm size classifications (micro, SME and large). This represents a major addition to the research project that we hope will provide greater insight both here and in any further research. The resultant database created is called the Oxford Firm Level IP database or OFLIP for short.

Why is it interesting to analysis the IP activity of SMEs? There are a wide range of reasons including:

- The innovativeness of SMEs is central to the performance of the UK economy and IP is one of the main policy-related measures to encourage innovation. IP offers firms an incentive to invest in innovation by protecting (to some degree) the innovation from imitation by competitors.
- Debates over the effectiveness of the IP system as an incentive to innovate benefit from accurate data on which firms are using IP and how such firms perform. There are many questions surrounding whether, when and how SMEs use IP.
- A longstanding policy concern is the issue of whether SMEs are disadvantaged in comparison with larger firms in their use of the IP system. This could be due to lower access to information about acquiring IPs and/or a lower ability to challenge other firms' IP, as well as enforce their own IP (due to the costs involved in undertaking legal cases).
- A first step in flagging up whether such differential access and use of the IP system exists between SMEs and larger firms requires the examination of how much use is made of the IP system by firms of different sizes.

As well as concern that SMEs may make less use of the IP protection system, there is also a longstanding debate about whether smaller firms are able to create as many innovations in proportion to their size as do larger firms. Some of the factors thought to contribute to fewer innovations from SMEs are those connected to their willingness to engage in risky R&D investment. Given the indivisible nature of much R&D that requires a large commitment to particular avenues for invention, and given also that a high proportion of research projects do not result in a commercially viable produce or process, smaller firms undeniably will face a higher risk of bankruptcy from engaging in R&D. Larger firms with several avenues of R&D investment relating to multiple product lines are able to diversify their R&D risk within the company. In addition their ability to finance R&D from internal funds can lower the costs of their R&D investment, whereas liquidity constraints may constrain smaller firms even if they are willing to risk the business on an exploratory R&D project. Even allowing for the possibility of fewer innovations being protected by IP in smaller firms, we can gain some indication of the

innovation rates in SMEs by our documentation of the IP assets sought by these firms.

1.1. Background

1.1.1. The FAME database

The broad characteristics of the FAME are as follows. In the December 2006 edition of FAME there are around 2.04 million ‘active’ firms, or companies, in the database (the words ‘firm’, ‘company’ and ‘enterprise’ are used as synonyms in this report). All of these firms have basic information, such as name, registered address, directors and registered number. For firms that have filed a set of annual accounts there is also some financial data available. The extent of this financial data varies substantially across firms, as the smallest firms legally need only report very basic balance sheet data (namely shareholders’ funds and total assets). The largest firms provide a wide range of Profit and Loss information as well as detailed balance sheet data. The FAME data also lists around 0.9 million ‘inactive’ limited companies. ‘Inactive’ refers to firms that have been dissolved, liquidated, entered receivership or declared non-trading³.

1.1.2. Defining small and medium sized enterprises (SMEs)

This research project is concerned with small and medium sized enterprises (SMEs). The European Union defines SMEs using three criteria: employment, turnover and assets. Since total assets are the most common financial variable in the FAME database, we define an initial SME group using this variable. According to the EU, an SME must have total assets greater than Euro 2 million and less than or equal to Euro 43 million. (Euros are converted to £s at the rate of 1.49). We then consider firms that have employment data (only around 3% of FAME firms report employment). Any firm that has employment greater than or equal to 250 is reclassified as a ‘large’ firm. In addition, any firm whose total asset value is less than Euro 2 million but has employment greater than or equal to 10 is reclassified as an SME.

Next we consider firms that are subsidiaries of other firms. The FAME data contains a variable for the ‘ultimate holding company’ of any subsidiary (this is based on last available accounts). If an SME is wholly-owned by a ‘large’ firm, it is inappropriate to treat the firm as an SME.⁴ Hence, any SME wholly owned by a large holding firm is

³ The fact that FAME represents the population of UK firms, and that it keeps exited firms in form of switching their status from active to inactive, allows tracking market entry and exit.

⁴ For example, it could be that one SME subsidiary of a large firm conducts R&D and files for patents for the entire group. Including such an SME would bias upwards the IP activity of SMEs. Alternatively, if we were analysing whether SME access to finance was an issue for policy, the inclusion of subsidiaries of large firms could bias results. Subsidiaries are likely to benefit from the resources of the larger group in terms of finance, skills and knowledge.

reclassified as a 'large' firm. Similarly, any micro firm wholly owned by an SME is reclassified as an SME. In situations where a firm is owned by two or more different sized holding firms we do not reclassify it.

Reclassifying SMEs according to the size of their holding company is only possible if we have the data on holding company size. For UK holding companies, FAME has this information. However, in the case of foreign owned SMEs there is no data on the size of the holding company. FAME provides only limited information on the nature of foreign holding companies (for example in over 80% of cases there is no information on size of shareholding). This presents a problem since excluding foreign owned SMEs could remove many majority owned UK firms; however, in some cases – such as being owned by Ford or Toshiba – it is important to know. Given this, in the analysis below we compare all SME data with foreign-owned SME data at certain points.

Finally, we make an adjustment for the fact that the FAME Dec 2006 database does not have accounting data for many firms in 2005 (due to delays in filing financial accounts). This means, for example, that an SME in 2004 could have missing asset and employment data in 2005, hence would be classified as a micro firm. To avoid this we classify such firms as an SME in 2005 if it was an SME in 2004 (and has missing accounting data in 2005).

Table 1 indicates that based on these criteria there are 159,399 SMEs in the FAME data in 2005. The large number of micro firms – those with assets less than £1.3 million, or with missing asset data – is noteworthy. Micro firms include those firms that have recently incorporated but have not yet had to submit an annual report. For example, in 2005, 368,469 firms were incorporated in the UK according to FAME.

Table 1 UK companies in FAME database (2005)

	Trading Companies
All companies	2,198,825
Large (> £28.7m total assets)	88,832
SMEs (£1.3m < assets < £28.7m)	159,399
Micro (assets <= £1.3m)	1,950,594

Note: See main text for full explanation of firm groups.

In this report we consider IP activity in the period 2001 to 2005. An important question is to what extent the FAME data captures the entire population of British companies over this period? Since FAME takes its data direct from Companies House the data should capture the entire population. However, since we are assessing past IP activity, it is possible that an SME may be IP active in 2001 but subsequently go out of business

(which we call 'exit'). This is captured by FAME to the extent that the 'inactive' companies in FAME include all firms that have exited since 2001. The FAME Dec 2006 data contains 926,503 firms that are now classified as non-trading. The FAME database keeps inactive firms for at least five years (from dissolution), hence the data we use should capture all firms.

1.1.3. IP data

The IP data used in the research comes from three different sources: the UK IP Office, Marquesa Ltd and European Patent Office (EPO) ESPACE Bulletin. Data on UK patent publications were supplied by the UK IP Office.⁵ Marquesa Ltd supplied data on UK trade mark publications and Community marks registered.⁶ The Community trade mark data includes International Marks designating the EU (the Office of the Harmonisation of the Internal Market, OHIM, which issues Community marks allowed these since 1st October 2004). Data on EPO publications by British entities was downloaded from ESPACE Bulletin DVD 2006/001. A brief explanation of the different types of IP is given in Appendix 3.

This report focuses on publications of UK patents, trade marks and EPO patents, as well as registrations for Community trade marks. For each of these we do have an associated application date, although only for IP that has been published. Equally, for those patents which succeeded in being granted there is a grant year. Analysis of the relative success rates of SMEs versus other companies, or the lag time between application and grant, are not contained in this report.

The rationale for using publication year, rather than application or grant year, is that one of our major interests is in using IP as a proxy for a firm's innovation. It is these changes that should affect firm performance and publication year may best capture when these changes occur. In summary, we use the publication date because it proxies better innovation output and the start of competitive advantages gained through innovation. Using application or priority date might precede the innovation; using grant date might lag the innovation. Further, using grant date restricts the IP measure to only those granted and we are interested in any firm level innovation even if such innovation did not qualify for a full IP right.

Table 2 shows the number of SMEs listed in the FAME database for each of the years 2001 to 2005. It shows that the numbers rise from 130 to 158 thousand in 2004 (the 2005 figure may be slightly lower than trend since many SMEs have not yet reported

⁵ The authors gratefully acknowledge the support of Jim Houlihan, Graham Jarman and their colleagues at the UK Intellectual Property Office.

⁶ The data supplied on Community trade marks did not have a publication year. The authors gratefully acknowledge the support of Christopher Durrant and colleagues at Marquesa for clarification of this information.

financial accounts). Out of these firms around 3,300 are IP active in any year – that is have at least one patent or trade mark publication in the year – which is around 2.2 to 2.4%. If anything, the trend in this figure is falling slightly, but the difficulty in interpreting 2005 (due to lack of complete financial data) makes this uncertain. The last row of the table looks at any firm that was an SME in any of the years. There were 213,855 SMEs overall, this is larger than any single year since, for example, some SMEs in 2001 grow into large firms in by 2004. Out of these firms, around 4.8% used IP at some stage in the five-year period. This is comparable with large firms, of which 5.4% were IP active in the same period, but much higher than micro firms, of which only 0.8% were IP active.

Table 2 Coverage of SMEs in FAME and IP active SMEs (2001-2005)

Year	All trading SMEs	IP active SMEs	%	Foreign owned IP active SMEs
2001	130,082	3,123	2.41%	574
2002	138,243	3,365	2.43%	577
2003	148,215	3,330	2.25%	547
2004	158,221	3,325	2.10%	506
2005	159,399	3,547	2.23%	514
2001-2005	213,855	10,269	4.80%	1,604

Table 2 also shows the number of foreign owned SMEs in the sample of IP active firms. As mentioned above, we do not have full information of the nature of foreign ownership (e.g. whether wholly or partly owned). There is reasonable coverage of the country of ownership, which shows that the leading country is the US (with around 200 SMEs, or 40%), followed by Japan, France and Germany (with around 6% each). There is slight evidence that the number of foreign owned IP active firms is falling.

2. Matching methodology

The basic method of matching was to use the company name from FAME and the applicant name from IP data. Since IP records do not include the registered number of the company it was not possible to match on this. Matching on the basis of company name requires names to be ‘standardised’ in both data sets prior to analysis (e.g. the removal of capitals and standardised of Limited to Ltd, etc). Considerable attention to this process, as well as considerable past experience, means that we expect this matching method to be highly successful. The matching procedure also took account of changes of the name of firms since 2000.

To gauge the outcome of the matching procedure requires comparison of our data to external sources. This is difficult since there have been no comparable matches of IP to UK firms. Nevertheless, we can gain some insight from looking at official data on all IP activity. Table 3 summarises our matches and also some official sources for the year 2003. The official sources count all IP from UK residents, whether corporate or personal, hence we would expect them to be greater. Equally, the FAME database only contains registered firms and there are a large number of unregistered businesses in Britain.

Table 3 Benchmarking the matching outcome (number of publications in 2003)

	Official Data	OFLIP Data	Percentage (%)
UKIP – UK patents	5,708	4,084	71.5
UKIP – UK trade marks	18,071*	12,484	69.1
OHIM – Community marks**	6,301	4,478	71.1
EPO – European patents	4,361	4,132	94.7

Note: The number for ‘Official data’ for British-based applications published are from UKIP *Facts and Figures 2004/5*. *This is an estimate of the number of publications based on UKIP correspondence. There were 21,260 applications in 2003 and UKIP estimate 85% are published. EPO and OHIM figures are taken from web-sites. ** Community trade mark data throughout the report refer to registrations. The comparability of the official and OFLIP is only crude for reasons outlined in the main text. In addition, for patents, official data refers to the nationality of first applicant, whereas our data are based on whether any applicant is British.

As can be seen from the table the number of IP publications in OFLIP is around 70% of all IP publications for UK patents, trade marks and Community trade marks. It is higher (95%) for EPO publications, which makes sense in that most of these are likely to come from registered companies listed in FAME. Focusing on SME behaviour, it is also possible that IP is held under the names of the company directors (perhaps because they filed for the IP before registering the company). Although this was not the focus of the study, we did undertake a trial match of all company director names with the list of UK patents in 2000. Information on director surname, first name and postcode was used. This matching process is more difficult than using firm names since personal names can have many duplications. In the FAME data there are around 12 million past and present directors. The preliminary results for 2000 indicated that directors had around 500 UK patent publications.

3. Trends in IP activity

Figure 1 shows the total number of all publications by UK registered firms (and registrations for Community trade marks) in each of the years 2001 to 2005. Note that this is based on data for all firms – whether micro, SME or large. Overall, UK patents have seen a fall, from 4,272 in 2001 to 3,709 in 2005, whereas EPO patents and UK

trade marks have been roughly constant (at around 4,000 and 12,00 per year respectively). Only Community trade marks (CTMs) have seen a growth over the period. Between 2001 and 2004 registrations grew from 4,004 to 4,986, with the 2005 figure being much higher at 8,241. In October 2004, the OHIM, which issues the Community trade mark, became a signatory of the Madrid Protocol and this may have increased the attractiveness of using a Community mark. This said, there was no corresponding fall in UK trade marks in 2005.

Figure 1 Total numbers of publications (by year)

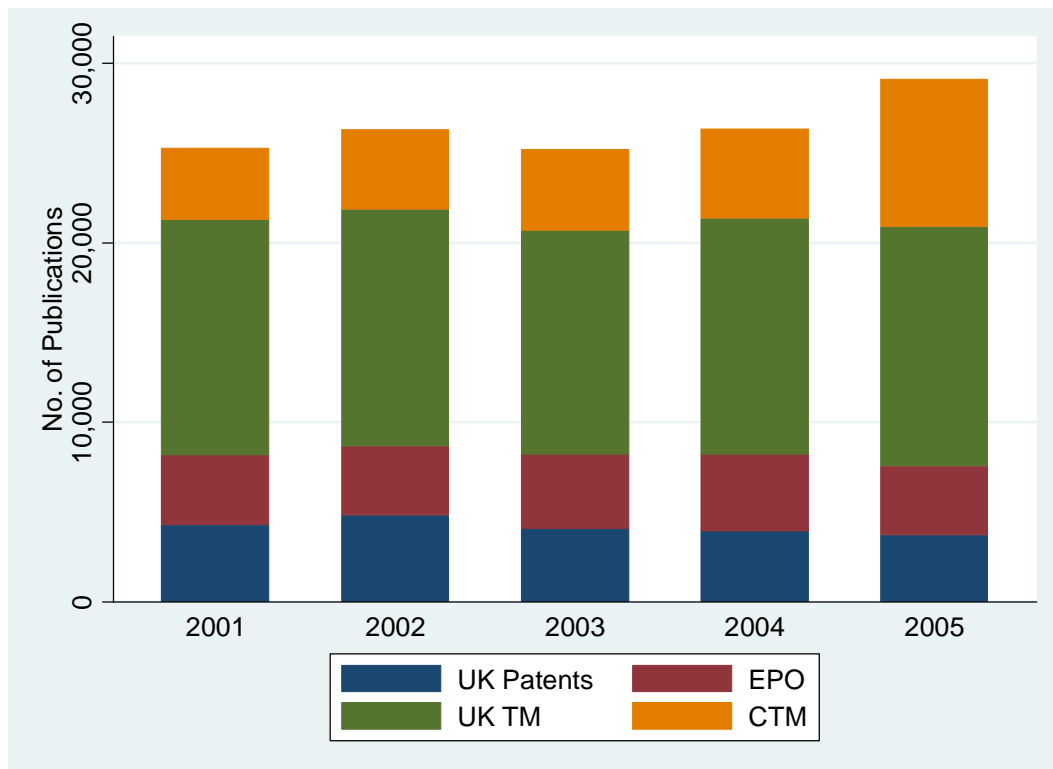


Figure 2 breaks down the patent data in Figure 1 by firm size category. The major trend shown in the figure is the falling level of UK patents by large UK firms; note that this has not been offset by rising EPO patents.⁷ For SMEs and micro firms the 2001 to 2004 data indicates a slight rising trend, with 2005 being lower than would be expected. As indicated in section 1.1, for SMEs this could be due to lack of reported financial data, but for micro firms the 2005 figure should be unbiased. The level of patenting in large firms was already being matched by the total of that in SMEs and micro firms by 2003 and by 2005 these smaller firms were together exceeding the contribution of large firms.

⁷ It could be that large UK firms are increasingly using US patents, something we currently cannot check using the OFLIP data.

Figure 2 Numbers of patents (by year and firm size)

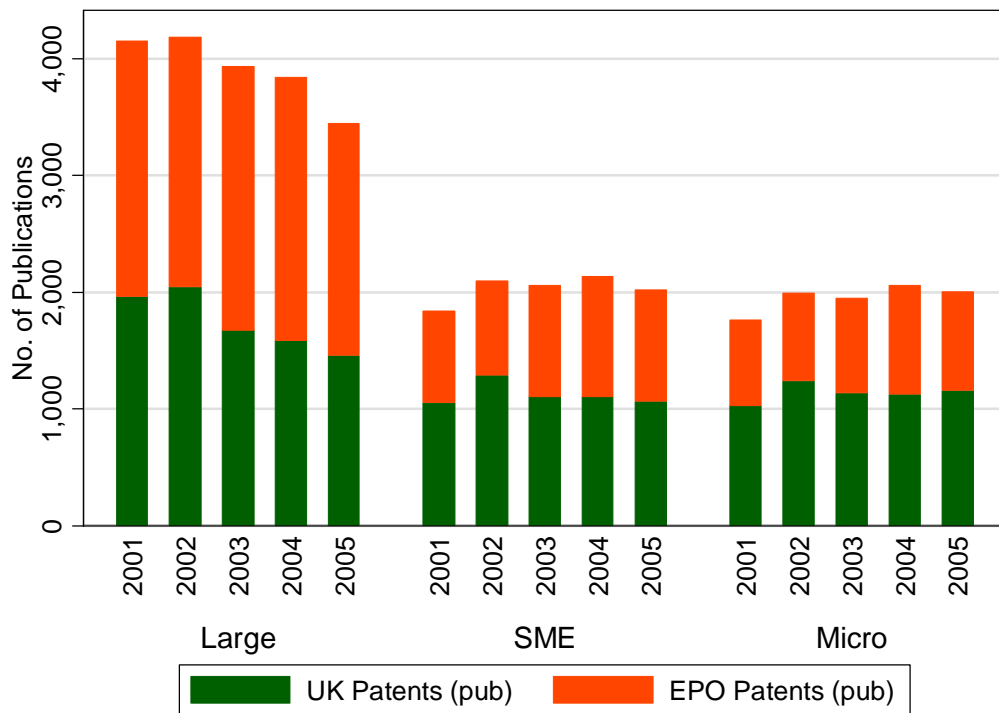
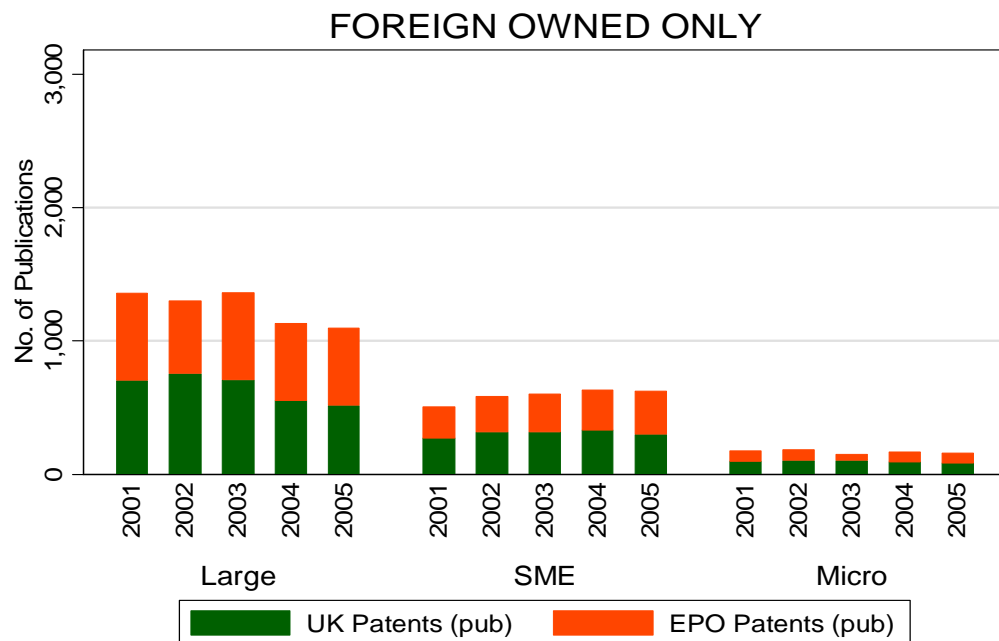


Figure 3 Numbers of patents by foreign-owned firms (by year and size)



As discussed above, some of the SMEs are foreign owned by companies for which we do not have full financial information. Does the inclusion of such firms have an important impact? Figure 3 shows the numbers of patents by foreign owned firms (note that the size category now refers to the subsidiary itself – since there is no data on size of foreign firm that owns part, or all, of the firm). The figure shows that foreign owned SMEs account for around 500-600 patents out of the SME total of around 2,000.

For comparison, Figure 4 shows the numbers of patents by domestically owned firms. Looking at the SMEs, it is clear that over the 2001-2005 period there has been no significant upward trend in patenting. The year 2005 may be biased slightly lower for reasons discussed above, but even allowing for this the best summary of the period is one of “steady numbers”. The relative contribution of SMEs and micro firms to total patents by domestically owned firms is now even bigger, mirroring the concentration of foreign owned firms in the large firm category.

Figure 4 Numbers of patents by domestic owned firms (by year and size)

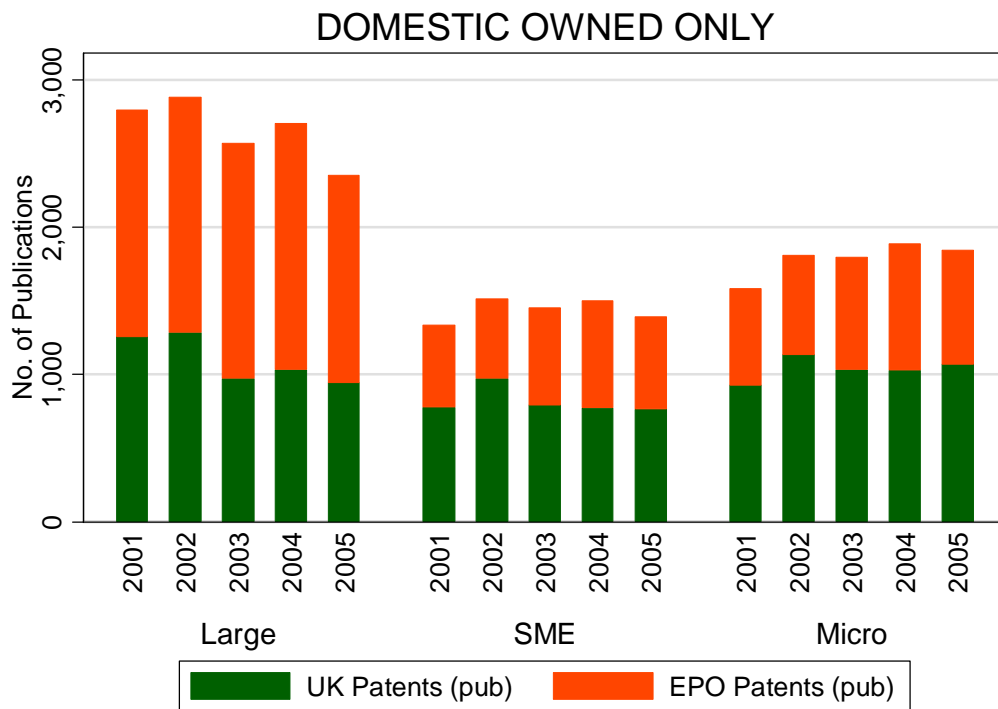
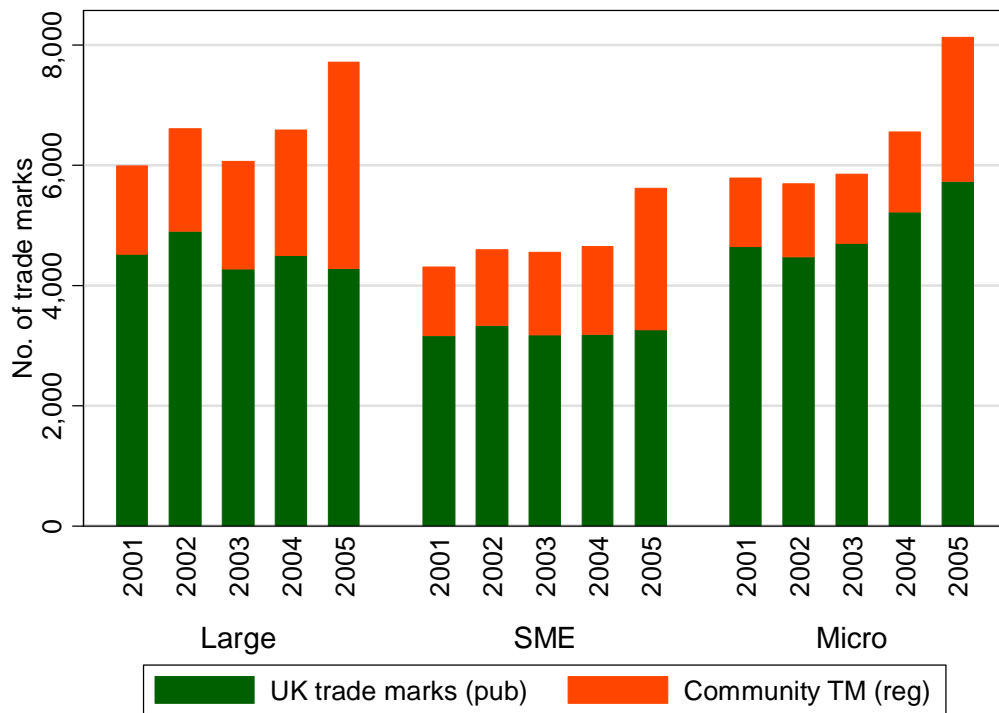


Figure 5 shows a size breakdown for trade marks. The striking feature of this chart is the high relative level of trade mark applications by all SME and micro firms compared to the large firms in all years. The major trend here is the increasing number of total trade marks for all firm sizes. For large firms and SMEs this overall trend is driven by the increasing use of Community trade marks, especially in 2005. For micro firms, both UK and Community trade marks usage is increasing over time. As noted above, on 1st October 2004 the Office for the Harmonization of the Internal Market (OHIM), which is the agency that issues CTMs, signed the Madrid Protocol. Hence it may be that this change was behind the higher numbers of CTMs we observe in our data.

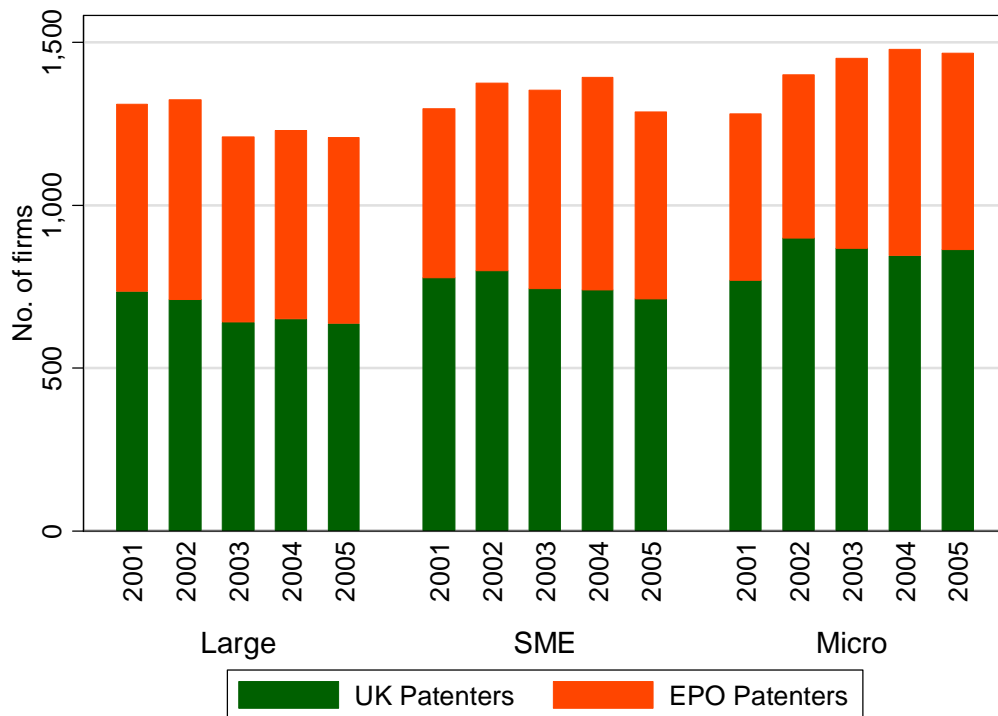
What is the contribution to these numbers by foreign owned firms? Overall, it is much less than with patents. For SMEs, for example, foreign owned firms account for less than 700 trade marks in total (around 15%). Hence, we do not plot their contribution in a separate graph.

Figure 5 Numbers of trade marks (by year and size)



Changes in the total number of publications can come from two sources: either more (or less) firms can become active, or a fixed number of firms can have more (or less) publications each. Figure 6 looks at the number of firms that are patent active by firm size. For large firms, the patent data indicates that fewer firms had a UK patent published after 2002, whereas the numbers using EPO patents is roughly constant. Comparing Figure 6 with Figure 2 does suggest a slight fall in the number of UK patents per large firm.⁸ In contrast, more SMEs patent over the 2001 to 2004 period, and the same is true for micro firms. However again comparing Figures 6 and 2 we see that the average number of patents per firm is much higher for the large firm category than for either SMEs or micro firms, with larger firms averaging about 2.9 patents per firm in 2005 compared with 1.5 or less for SMEs and micro firms.

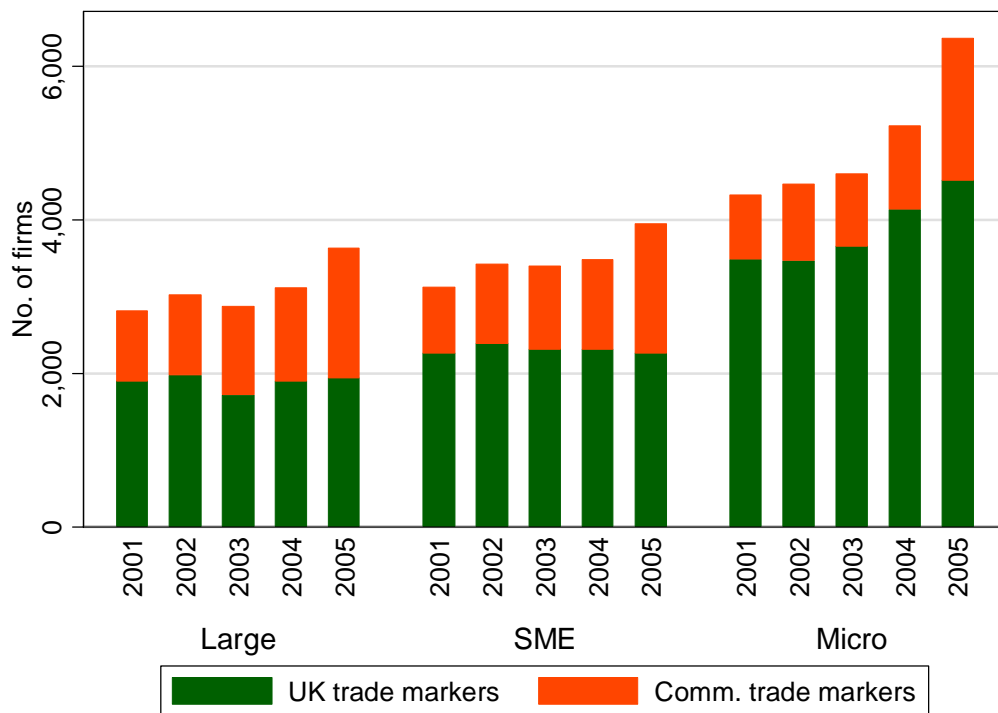
Figure 6 Numbers of firms that patent (by year and size)



⁸ Earlier research for large firms over the period 1996-2000 has shown that the proportion of manufacturing firms publishing UK patents was flat whereas it was rising for EPO patents – see Greenhalgh and Rogers ‘Intellectual property activity by service sector and manufacturing firms in the UK, 1996-2000’ in H. Scarbrough (ed.) *The Evolution of Business Knowledge*, forthcoming Oxford University Press 2007.

Figure 7 shows the number of firms that seek to acquire new trade marks. All firm sizes have increasing numbers of trade mark active firms. For large and SME groups this is driven by the numbers that are active in CTMs, but for micro firms increasing activity in UKTMs and CTMs are both important. Comparing Figures 5 and 7 shows that again the number of these IP assets per firm is highest in large firms by a factor of 50%. Whether these large firms are proportionately more active in either patents or trade marks given their much larger average size remains to be evaluated below (section 5).⁹

Figure 7 Numbers of firms that trade mark (by year and size)



⁹ Greenhalgh and Rogers, op.cit. found that, within a large firm database, smaller firms were more IP active relative to size measured by employment.

4. The characteristics of IP active firms

This section analyses the characteristics of IP active firms. The initial sub-sections look at some basic characteristics, such as age and sector, with later sub-sections looking at a range of financial and other characteristics.

4.1. Age of firm

This section takes a snap shot of firms in 2004 and analyses their ‘age’, where age of SME is defined by years since incorporation. Figure 8 shows two bar charts. The top bar chart is for all SMEs that are not patent active and shows the distribution of incorporation years. Note that firms incorporated in 1980 or before are all shown in the first bar (the oldest SME incorporation date in FAME is 1856). The lower bar chart shows the distribution for patent active firms. The main difference between the two graphs is that patent active firms are under-represented in the most recent years (from 2001). Since the patent data is for patents published – which takes place 18 months after application – it is clear there may well be under-representation of recently incorporated firms (i.e. a newly incorporated firm in 2004, even if it has applied for a patent, will not get it published until 2005).

Figure 8 Incorporation year of patent active SMEs vs. all SMEs (2004)

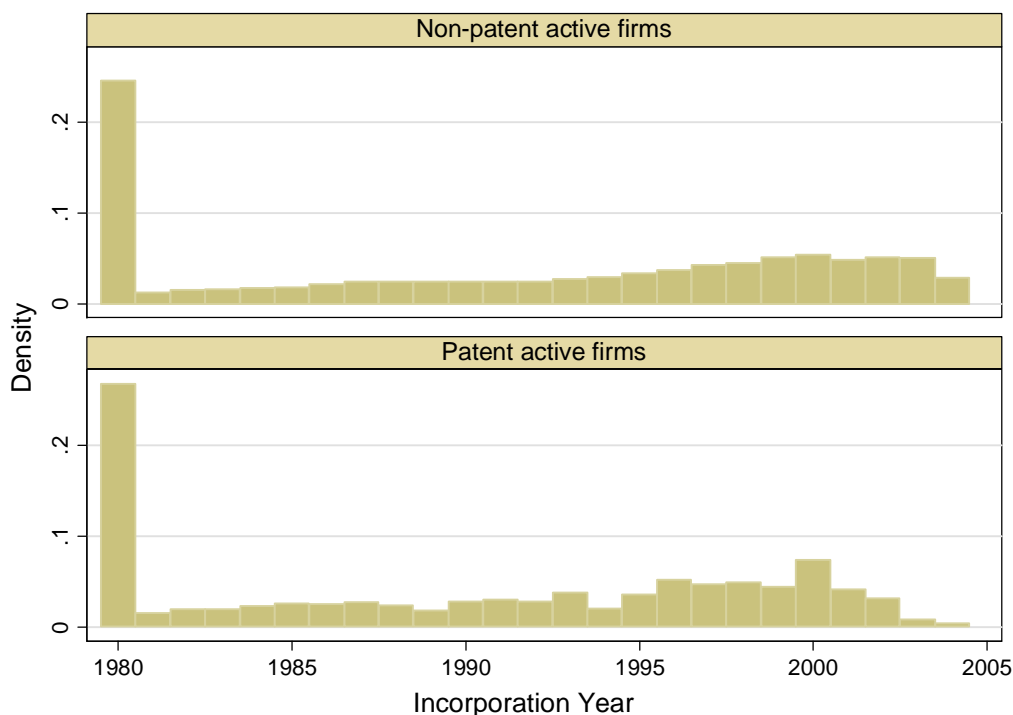


Figure 8 implies that 2001 and 2002 incorporated SMEs appear under-represented, but note that the year 2000 appears over-represented. Equally, the number of patent active firms incorporated in or before 1980 also seems slightly higher than non-patent active SMEs. This somewhat complex situation requires some further analysis, see Table 4 below, but first the situation for trade marks is shown in Figure 9. In the case of trade marks the two distributions appear more similar. Again there is an under-representation of very young SMEs in 2003 and 2004, but apart from this it is difficult to perceive any differences.

Figure 9 Incorporation year of trade mark active SMEs vs. all SMEs (2004)

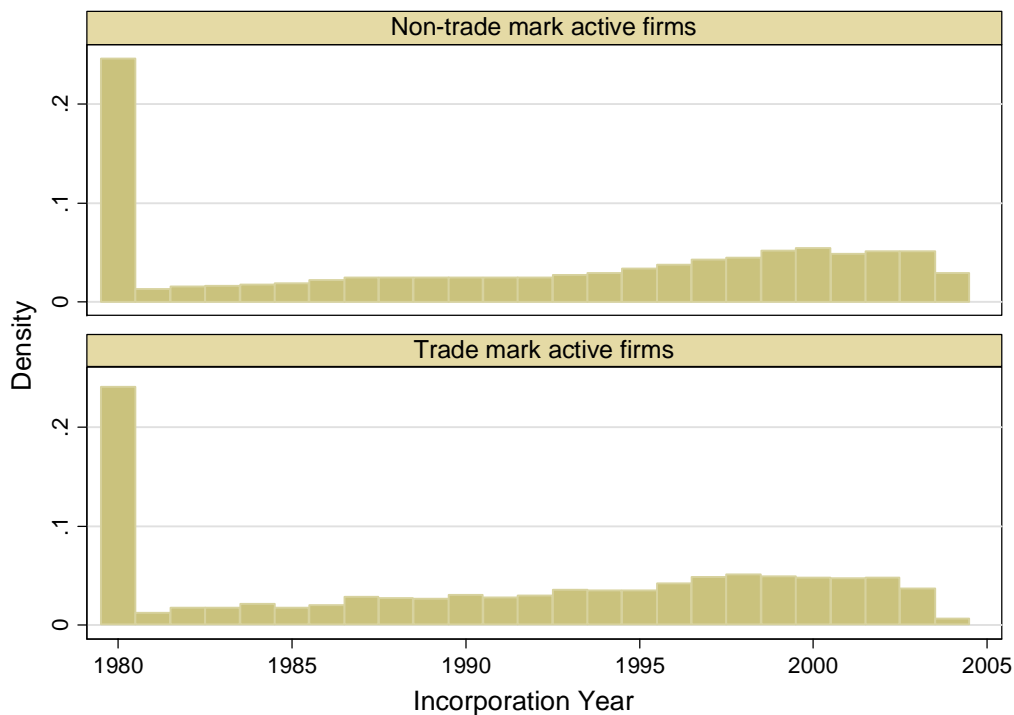


Table 4 converts the incorporation year into age. For example, a firm incorporated in 2004 has an age of 'one'; a firm incorporated in 2000 has an age of 'five'. The first column of numbers shows the percentage of each age group for all SMEs. For example, 2.9% are one year old, and 21% are between 6 and 10 years old. Note that the first five years of existence are the most critical ones for SME survival. Overall the distribution is almost balanced between those over 10 (55%) and those that are 10 or less (45%) so the median age is around 11, while the under 10 group is again divided almost equally between those that are 5 and under (23%) and those that are 6 to 10 (21%). The next four columns show the equivalent percentage distributions for those SMEs that are UK trade mark active, CTM active, UK patent active and EPO active. For firms that are active in UK trade marks, the differences in age distribution with all SMEs are very slight. For firms that are CTM active the major difference is that firms cluster more strongly in the 6 to 10 year age group. For patenters the differences are more notable: UK patent active firms are more likely to be aged 5 than are all firms and also more likely to be much older SMEs (aged more than 10). For EPO patent active firms the age distribution

is again heaped in age 5, but also clusters in ages 6 to 10 with fewer aged 10+ in comparison with all firms.

Table 4 was also calculated for the foreign owned SMEs. The results indicated that, as might be expected, the foreign owned SMEs were in general older, with fewer firms aged one and two, and more firms in the 10+ category. For patents, foreign owned SMEs also showed higher numbers in age five than in ages less than five. To sum up, SME firms active in seeking to acquire either UK patents or European IP rights, whether patents or trade marks, are generally less likely to be firms within 4 years of incorporation than firms that are not active in these types of IP. Firms that are UK trade mark active have a very similar age distribution to all firms.

Table 4 Age of SME and IP activity (for 2004)

Firm age (years)	All SMEs	UK TM Active SMEs	CTM Active SMEs	UK Pat Active SMEs	EPO patent Active SMEs
1	2.91	2.16	2.24	1.89	2.15
2	5.08	5.30	3.53	2.84	1.69
3	5.13	5.99	5.07	2.84	4.76
4	4.87	5.17	5.25	5.27	4.92
5	5.45	5.13	5.25	7.43	8.60
6 – 10	21.11	21.22	25.80	19.86	24.88
10+	55.45	55.02	52.88	59.86	53.00

Note: Table shows the percentage of firms in age range shown. The columns indicate the sample of firms. 'All SMEs' are all SMEs in FAME data. 'UK TM' are SMEs that are trade mark active, etc.

4.2. Industry

This section looks at how IP activity is distributed across sectors and industries. At the outset it is worth noting that it is very rare for such an analysis to be possible. While it is common for IP data to be disaggregated by class (e.g. trade mark class), it is generally not possible to map this to industrial classification. The OFLIP data allows such a mapping since the firm-level data contains an industrial classification on most firms. While the FAME data has a standard industrial classification (SIC) at the 4-digit level, this section concentrates on the 1-digit, or sector, level (for SMEs only). Some examples of 2-digit disaggregations are shown, but complete analysis would require much more space.

Table 5 shows a breakdown of SME activity by sector and type of IP. The first two columns refer to UK trade mark activity. The first column shows the number of active SMEs, while the second column shows the average number of trade marks per IP active SME. For example, there were 2,226 SMEs in manufacturing over the 2001 to 2005 period that had a UK trade mark published, and the average per SME was 1.7. For UK trade marks, the other leading sectors are ‘Wholesale, retail and hotels’ with 2,507 and ‘Business Services’ with 1,383 active firms.

Table 5 IP active SMEs and average publications (by sector, 2001-2005)

Sector	UK TM	Av	Com. TM	Av	UK Pat	Av	EPO patent	Av
Agric. Mining	420	1.6	148	1.7	35	2.1	38	2.1
Manufacturing	2,226	1.7	1,307	1.6	1,734	1.6	1,202	1.7
EGW, construction	204	1.4	33	1.5	94	1.4	33	1.3
Whole, retail, hotel	2,507	1.8	1,004	1.8	243	1.7	131	1.4
Transport, telecom.	292	1.7	154	1.6	43	5.0	26	2.3
Finance, real estate	445	1.5	150	1.3	21	1.2	15	1.2
Computer related	576	1.6	596	1.6	185	2.0	158	1.8
R&D services	128	2.4	127	1.5	227	3.4	372	2.6
Business Services	1,383	1.6	699	1.6	321	1.9	262	2.3
Health, educ, culture	1,073	1.6	428	1.5	99	1.4	116	1.7
Missing in FAME	191	1.7	136	1.5	99	1.3	70	1.8
All sectors	9,445	1.7	4,782	1.6	3,101	1.8	2,423	1.9

Note: Columns show the number of IP active firms in each sector and also the average number of publications (or registrations for CTMs) for each firm.

A summary of some of the major findings from Table 5 are as follows:

- Over the 2001 to 2005 period, 9,445 SMEs were active in UK trade marking. The next highest IP activity was in CTMs (4,782 SMEs), then UK patents (3,101) and EPO patents (2,423).
- The average number of IP assets per firm were surprisingly similar ranging from 1.6 to 1.9, with slightly higher rates of patenting.¹⁰

¹⁰ The surprise here is that earlier work for larger firms has shown much higher numbers of trade marks per firm than patents – see Greenhalgh and Rogers, op. cit. Appendix Table A3.

- For UK trade marks, the largest number of active SME firms was in the 'wholesale, retail and hotels' sector and, within this, 'wholesale' dominates (accounting for around 2,000 of these firms).
- The other members of the top three for UK marks were 'manufacturing' and 'business services'. The rates of UK trade marking per SME were 1.8 in 'wholesale, retail, hotels', 1.7 in 'manufacturing' and 1.6 in 'business services'.
- For Community trade marks the largest sectors are again 'manufacturing', 'wholesale, retail and hotels' and 'business services'. Out of these, business service SMEs apply for 1.6 CTM each, whereas the other two sectors average 1.6 and 1.8 per SME.
- For both UK and EPO patenting the dominant sector is 'manufacturing' as might be expected. Nevertheless, the average number of patents per firm in 'manufacturing' are slightly below the rates in all sectors, showing that where firms are patent active in services they are more intensively active.
- 'R&D services' has the next highest number of SMEs that are EPO patent active, and these firms average 2.6 patents each. This sector also records a high number of SMEs that are highly active in UK patenting.
- 'Business services' have the second highest number of SMEs active in UK patents with these firms achieving 1.9 patents per firm. This sector is also quite active in UK patents.

Table 6 shows a breakdown of the data for manufacturing into 2-digit SIC classifications. For UK trade marks, the manufacturing industry with the most active SMEs is Furniture with 463, and this industry is also highest in CTMs and a high performer in patenting also. Another industry that has relatively high numbers of IP active SMEs is 'fabricated metal products'. There were 337 SMEs over the 2001 to 2005 period from this industry that had a UK patent published, and 179 SMEs with at least one EPO patent. Table 6 and Table 14 in Appendix 1 (for non-manufacturing) give an indication of the type of analysis that is possible. Further breakdown of industrial categories could be undertaken and also combining this with other characteristics such as location might be interesting. Equally, these data could provide a starting point for other analysis such as survey or case study based research.

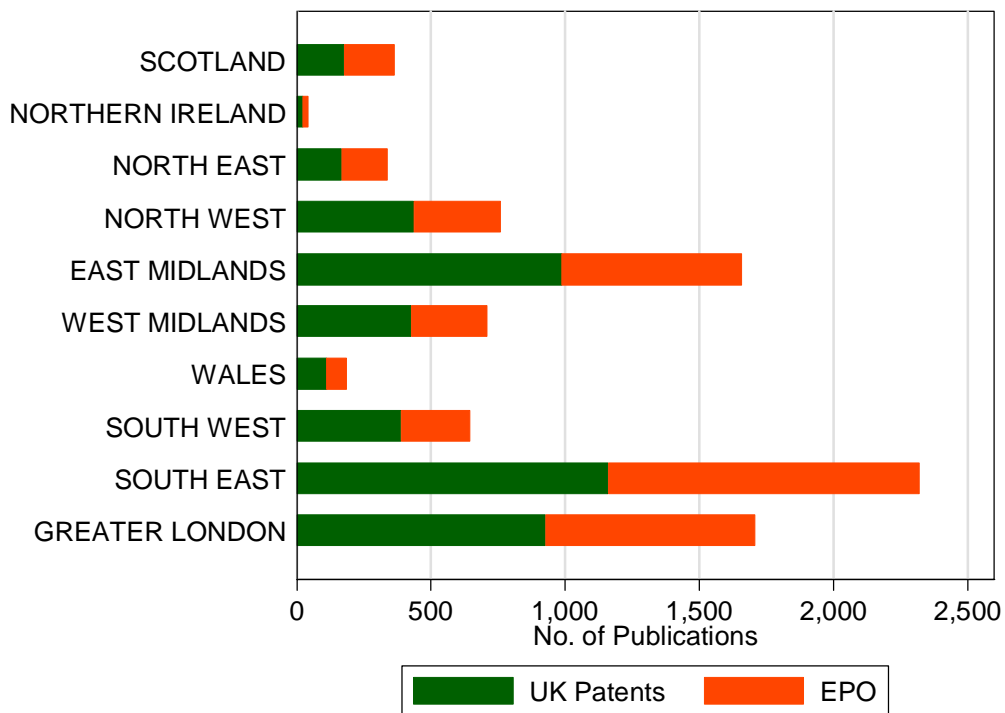
Table 6 IP active SMEs and average publications (manufacturing, 2001-2005)

Manufacturing industry	UK TM	Av Com. TM Av	UK Pat	Av	EPO patent	Av		
Food and Beverages	346	1.6	121	1.7	10	1.5	12	1.3
Tobacco Products	0	Na	0	na	1	1.0	1	2.0
Textiles	99	1.7	52	1.3	21	1.2	18	1.1
Wearing Apparel	63	1.5	40	1.4	6	2.0	4	1.0
Tanning & Dress. of Leather	17	1.9	20	1.2	1	1.0	1	1.0
Wood and Products of Wood	33	1.4	10	1.1	12	1.6	1	1.0
Pulp Paper and Paper Prod.	56	1.4	16	1.4	23	1.1	14	1.1
Publishing and Printing	196	1.6	115	1.5	44	1.4	34	1.5
Coke and Refined Petroleum	10	1.5	6	1.2	2	1.0	1	1.0
Chemicals and Chemical	291	2.0	208	1.7	107	1.4	158	1.8
Rubber and Plastic Prod.	120	1.5	61	1.6	131	1.5	79	1.4
Other Non-Metallic Minerals	63	1.6	21	1.5	30	1.7	11	1.5
Basic Metals	25	1.9	3	1.3	26	1.3	6	1.2
Fabricated Metal Products	226	1.4	121	1.4	337	1.5	179	1.4
Machinery and Equipment	139	1.6	91	1.6	211	1.5	155	1.4
Office Machines and Compu.	43	1.7	37	2.0	33	2.6	16	2.0
Electrical Machinery	133	1.7	94	1.7	159	1.6	112	1.6
Television and Line Telecom.	79	1.5	55	1.6	94	2.4	81	4.0
Medical and Optical Instru.	122	1.7	93	1.5	168	1.8	154	1.6
Motor Vehicles	24	1.8	16	1.3	33	1.8	21	1.4
Other Transport Equipment	12	1.3	10	1.4	15	1.2	6	1.0
Furniture Manufacture	463	2.0	235	1.7	278	1.3	149	1.3

4.3. Geographical location

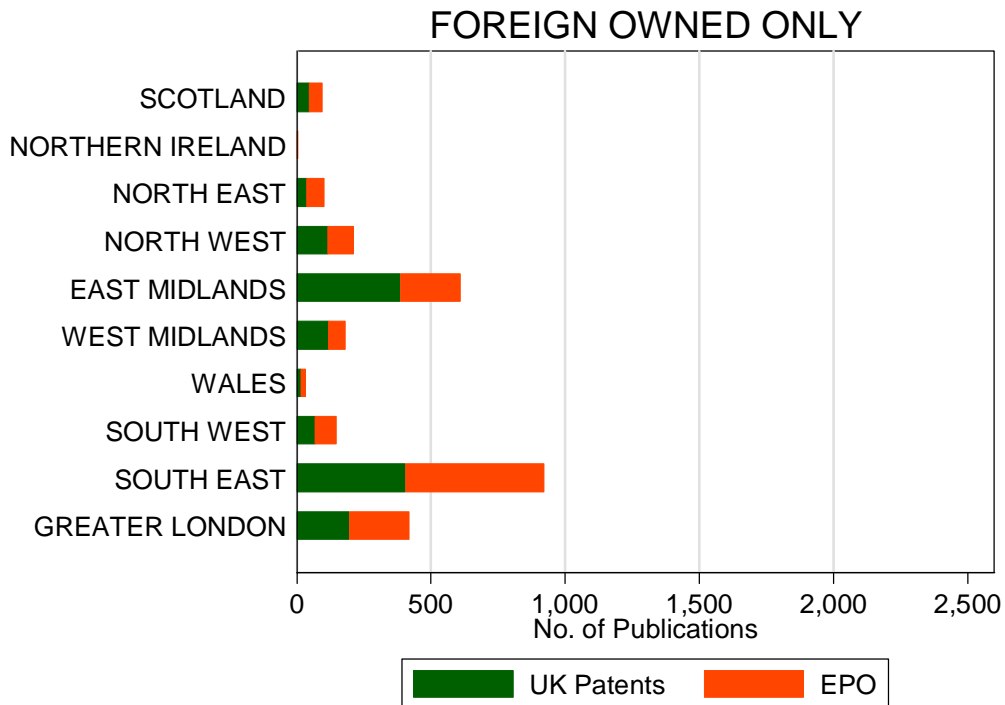
Figure 10 shows the number of patents published by SMEs for major regions in the UK. The region is determined by the postcode of the registered office of the SME. Three regions dominate: the South East, Greater London and the East Midlands. The latter includes the cities of Cambridge, Lincoln, Colchester, Ipswich and Nottingham. The ratio of UK patents to EPO patents is different across regions, with the South East around one whereas most regions have relatively fewer EPO patents.

Figure 10 Number of patents published by region (SMEs only, 2001-2005)



One issue is the extent to which foreign owned SMEs alter the distribution of patenting across regions. Figure 11 shows the patenting activity of such firms by region. The East Midlands and the South East dominate the figure. As examples, in the East Midlands the top foreign owned patenting SMEs are Toshiba UK Ltd (Japanese owned), Cambridge Consultants Ltd (ultimate holding company Altran Technologies, a French company) and Splashpower Ltd (owned by Splashpower Inc in the US).¹¹ In the South East, foreign owned SMEs are also important with the leading UK patenter being Roke Manor Research Ltd, which is ultimately owned by Siemens AG. Roke Manor averaged 46 UK patents and 16 EPO each year between 2001 and 2005. This highlights the importance of trying to distinguish between independent SMEs and those with parent companies, especially if these are large multinational firms.

Figure 11 Number of patents published by foreign owned SMEs (2001-2005)



¹¹ For information, Toshiba UK Ltd had 36 UK Patents in 2003, 33 in 2004, and 81 in 2005. Cambridge Consultants Ltd had 13 UK patents in 2002 and 3 or less in other years (and an average of over 3 EPO patents per year). Splashpower Ltd had 13 in 2004 and 3 in 2003 and 2005.

Figure 12 shows the situation for trade marking SMEs. Greater London dominates the figure. Equally, the Greater London region has a high CTM to UK trade mark ratio. These figures prompt further questions about why this should be the case. A first answer could be that foreign owned SMEs are driving the results. In the South East foreign owned SMEs account for 18% of CTMs, with the figure for Greater London being 23%. Both of these figures are higher than average (16%), but on their own they do not account for all the differences. Domestic owned SMEs in these regions are more likely to apply for CTMs.

Figure 12 **Number of trade marks by region (SMEs only, 2001-2005)**

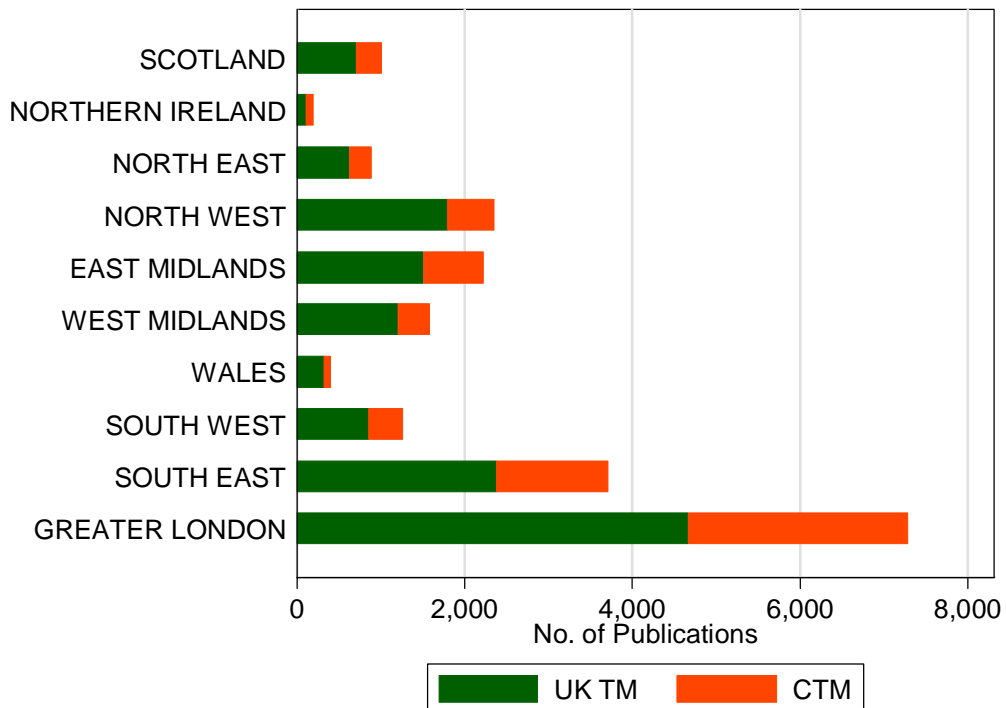


Table 7 analyses a further aspect of SME IP activity, which is made possible by also having data on large firm IP activity in the OFLIP database. The table shows the ratio of publications of SMEs to those taken out by large firms. For example, the ratio of SME UK patents to large firm patents is 0.62, while for trade marks the figure is 0.74. The lower the ratio the more dominant large firms are (or, put the other way, the higher the ratio the more dominant SMEs are). The table shows that the ratio varies greatly across regions. Although Greater London shows up strongly in Figures 10 and 12 as a region prone to acquire IP, its ratio of SME to large firms for all four IP types is rather low. In contrast, some regions have several ratios above 1, such as N. Ireland and the East Midlands, while Wales has a high ratio for UK trade marks. If we breakdown the 2.99 ratio for Wales for UK trade marks it comes from having 109 large firm trade marks and 326 from SMEs over 2001 to 2005 (micro firms had 578).¹²

Table 7 Ratio of SME to large firm IP by region (for 2001-2005)

Region	UK TM	Com. TM	UK Pat	EPO patent
All regions	0.74	0.74	0.62	0.57
Scotland	0.73	0.53	0.61	1.86
Northern Ireland	0.89	1.93	1.22	0.61
North East	0.67	0.95	0.72	1.21
North West	0.79	0.69	0.68	0.17
East Midlands	0.85	1.13	1.44	1.41
West Midlands	0.69	0.59	0.41	0.4
Wales	2.99	0.96	0.61	0.7
South West	0.83	0.99	0.73	0.65
South East	0.73	0.72	0.57	0.49
Greater London	0.56	0.59	0.39	0.19

4.4. Multiple IP activities

So far this report has looked at the different IP activities separately. An important question is the extent to which the same SMEs use each of the four IP types. Patent protection for the UK market can be sought via either UK or EPO routes. A firm might judge one invention to only be of use in the UK market, hence apply to UK IP office,

¹² The relatively low figure for large Welsh firms coincides with the fact that the maximum number of UK trade marks in any year for a large firm in Wales is 12 (Astra Games Limited); in Greater London it is 162 (Glaxo Group Ltd).

while another is judged to have EU market potential and therefore an EPO patent. A UK firm can also use the PCT system to gain protection overseas (PCT applications are counted in the publication data used here). Although these different routes complicate the picture, if the firm chooses a different route for each separate invention then there is no conceptual problem.¹³ However, the patent system also allows similar inventions to be filed in different offices. For example, it is possible for a UK firm to apply for a patent to the UK IP office and then apply to the EPO. The patent application may differ in terms of claims but there may be substantial areas of overlap. In such cases it is not clear whether we should count each application separately or count them as part of a single ‘patent family’. Investigating patent families is complex and requires more data than was available for this project, but we have conducted a basic analysis to assess the magnitudes that could be involved. Looking at UK firms that had one of more EPO patent published, we checked whether these patents had a priority date equal to the application date of a UK patent publication (by the same firm and in the same 4 digit IPC class). The fact that the EPO priority date matched the UK publication date is strong evidence that the patents are part of a family. Over the 2001 to 2005 period we find that 20% of EPO patents have a priority date from a UK patent publication. Table 8 shows the estimates by firm size and year. These indicate a slight fall in the proportion, although a comprehensive analysis would be required to confirm this trend.

Table 8 Number of EPO patents that have priority from UK patent (estimates)

Firm size	2001	2002	2003	2004	2005	
Large	436	398	417	354	292	
		20%	19%	18%	16%	15%
SME	167	182	176	189	167	
		21%	22%	19%	18%	17%
Micro	126	75	92	132	116	
		17%	10%	11%	14%	14%

Note: The table shows estimates of the number of EPO patent publications that have a priority date matching a UK patent publication application date (and also same application and 4-digit IPC code).

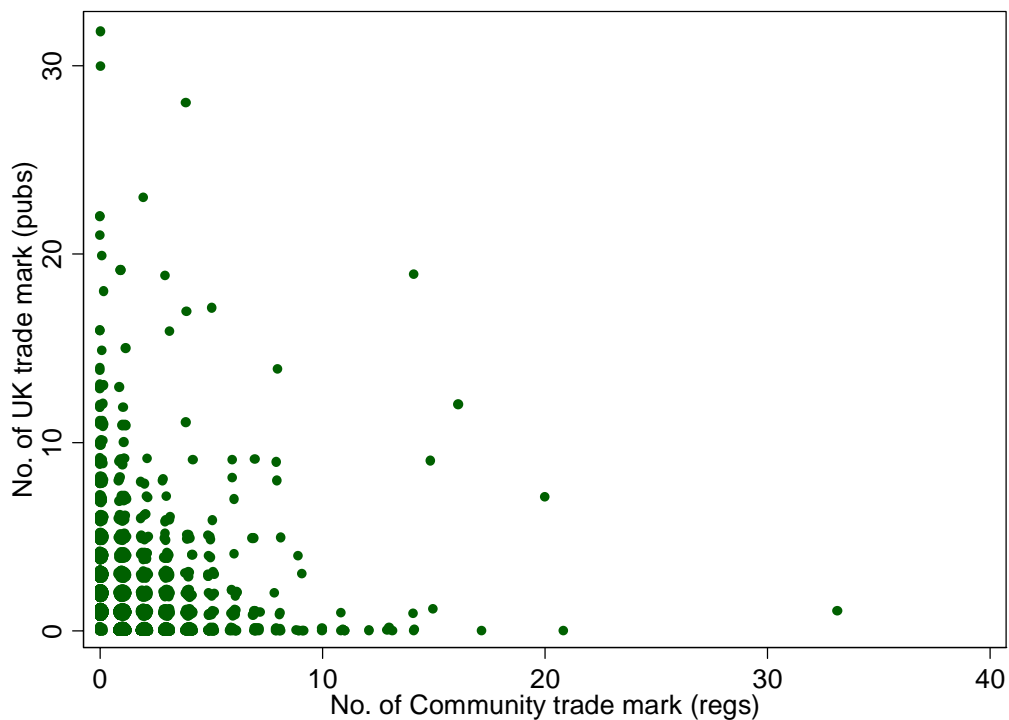
The situation regarding trade marks has similarities to that of patents. A UK firm can seek protection in the UK by either filing for a UK or a Community trade mark. The Community trade mark will also give protection in all EU countries. An existing UK trade mark may also be converted into a Community trade mark, hence there may be some element of double counting in the figures. Perhaps more importantly, the recent increases in Community marks could be due to ‘upgrading’ past UK trade marks. Hence,

¹³ The data here do not include US patents, but they do include PCTs that designate the UK. Hence, in the case of a UK firm that files under the PCT, nominating the US as well as the UK, our data on UK publications will capture this patent.

a Community mark registration may not represent innovation in the sense of a new product or service, rather the intention to market in the EU (or to prevent others from using the mark). The data available for this report was not detailed enough to investigate these issues for trade marks.

Figure 13 shows a scatter plot of the number of UK trade marks against the number of Community trade marks for all trade mark active SMEs. The scatter plot shows there are relatively few firms that have 10 or more trade marks in a year, and there are very few firms that have both 10 UK and 10 Community trade marks in a year. As an example of this small group, Knowledge & Merchandising Inc Ltd had 19 UK trade marks and 14 Community trade marks in 2005. The figure is not good at showing just how many times firms have one or two trade marks (since it has to over plot the points). In fact, in the majority of times (63%) an SME only obtains one trade mark in a year. In 20% of cases SMEs apply for two trade marks per year. In such cases do SMEs ever apply for both a UK and CTM in a single year? The answer is “yes”, but in only 391 out of the 2,638 cases where this happens (15%). As an SME trade marks more frequently, it is more likely it obtains both UK and CTM protection at the same time.

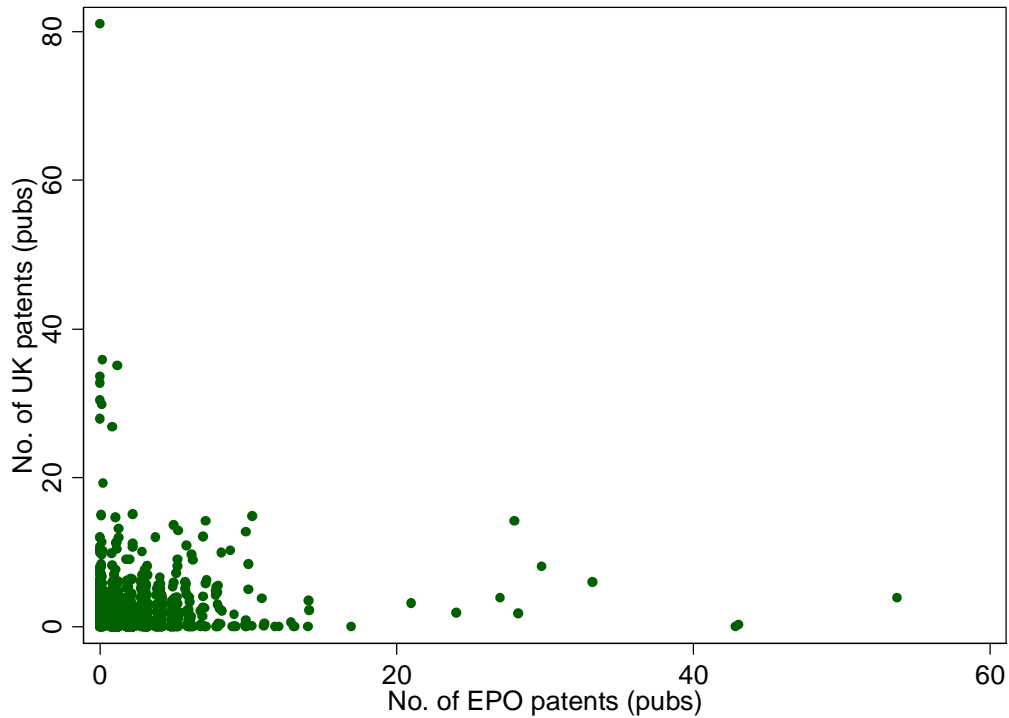
Figure 13 UK and Community trade marks for SMEs (2001 – 2005)



In summary, relatively few SMEs take out more than one trade mark per year. Those that do have multiple trade marks tend to opt for either the UK or CTM route, although there are still significant numbers of SMEs that use both methods of protection.

Figure 14 shows a plot of UK and EPO patents for SMEs. The figure shows one SME with 81 UK patents (this is Toshiba UK Ltd in 2005), along with small numbers of SMEs that file for multiple patents. As with trade marks, in the bulk of cases an SME only obtains a single patent in a given year (59%). In 20% of cases an SME applies for two patents and in around one third of these cases the SME applies for one UK and one EPO patent.

Figure 14 UK and EPO patents by SMEs (2001 – 2005)



4.5. Joint patent applications

A joint application is defined as when there is more than one applicant named on the IP right. A joint application indicates that the firm has cooperated with another entity, which could be an individual, firm or institution. It is also possible that the co-applicant could be a related firm – for example an associate firm – something that we have been unable to investigate under the scope of this project.

The percentage of joint patentees is shown in Table 9, where the data are broken down by firm size and UK and EPO patenting. For UK patents the overall proportion is 31% - perhaps a surprisingly large proportion. But within this it is domestically owned SMEs that have the lowest proportion (22%). Micro firms, in contrast, have a 33% proportion of joint patents. This could indicate that they do research more often with universities, or other firms, or possibly that individuals are also named as applicants. The number of

EPO patents that are joint is much lower at between 5% and 9%. In general we might expect EPO patents to be more valuable, but whether this drives the reduced proportion is unclear.

Table 9 Percentage of cases when firms involved in joint patenting (2001-2004)

Firm size	UK Patents (%)	EPO patent (%)
Large	36	9
SME	25	5
SME (Foreign owned)	34	7
SME (Domestic)	22	5
Micro	33	7
All firms	31	7

Note: The figures shown are calculated as follows. For each year in which a firm patents we calculate the average proportion of joint patents. The mean of this average across all firms for the years 2001 to 2005 is thus shown in the table as a percentage.

4.6. Patent applicant links with universities

The dataset also allows us to observe when a firm makes a joint patent with a university. To be precise, this information is gathered by searching the names of joint applicants for the word “University”. This may omit some higher education institutions that do not have “University” in their name, but we expect it to produce unbiased results when comparing across firm size groups. Clearly, such a method will not pick up collaboration with many overseas higher education institutions (i.e. most do not have “university” in their names).

Table 10 shows the average number of applications made jointly with a University. For all firms the figure is 1.7% for UK patents and 2.5% for EPO patents. What is, perhaps, surprising about the table is that micro firms have the highest proportion. Presumably micro patenting firms are much more likely to be spin-offs from universities, or work with universities.

Table 10 **Proportion of patents made jointly with universities (2001-2005)**

Firm size	Joint application with university (%)	
	UK Patent	EPO patent
Large	0.5	1.0
SME	0.7	0.7
SME (Foreign owned)	0.6	0.5
SME (Domestic)	0.7	0.8
Micro	3.2	5.3
All firms	1.7	2.5

Note: The figures shown are means across firms and years as in Table 9.

4.7. Profitability

This section analyses the current profitability of IP active firms. It is not intended to investigate why such differences occur. In particular, it could be that IP active firms have higher profitability due to the value of IP but, alternatively, it could be that profitable firms are more likely to use IP. Understanding causality is a difficult task and further analysis of this is contained in Report 2. This section takes a broad look at how profitability of IP active firms compares with non-IP active firms.

Profit data in FAME has considerably less coverage than asset data. For firms incorporated in 2004 or before, only 24% of firms in FAME have ‘net profit before tax’ data. For IP active firms this figure is 52%. A standard measure of profitability is return on assets, which we define as ‘net profit before tax’ / ‘total assets’. In any large data set there are many extreme values for such a ratio – the minimum value is minus a million and the maximum is over 2000 – caused by the fact that profits can be positive or negative and the denominator can be very small. This means that it is best to look the median as a measure of central tendency.

For all firms in FAME with profit data, the median return on assets is 3.5%, compared to IP active firms with 3%. Table 11 below shows how the median profitability varies across firm size and according to IP type.

Table 11 Median profitability of IP active firms by size (2001-2005)

Firm size	All FAME firms	UK TM Active	Com. TM Active	UK patent Active	EPO patent active
Large	3.84	4.53	4.27	4.34	3.63
SME (All)	3.89	4.29	2.18	2.69	-0.88
SME (Foreign owned)	3.07	3.56	1.29	2.38	0.74
SME (Domestic)	4.02	4.37	2.50	2.77	-1.67
Micro	0.36	-0.31	-16.7	-20.0	-43.4
All firms	3.52	3.85	2.66	2.76	0.61

Among all firms there are clear differences in the profitability of firms by size but it is the micro firms that are distinct, with very low return on assets. In contrast all SMEs compare favourably with all large firms, having similar median profitability, although here too there is a difference between foreign-owned and domestic SMEs, with the latter enjoying higher profitability.¹⁴

What is more striking is that whereas large IP active firms generally have higher profitability (for three of the four types of IP, the exception being EPO patents), SMEs have lower profitability (for three of the four types of IP, the exception being UK trade marks) and IP active micro firms have negative median profitability (for all four IP assets). The higher profitability of large IP active firms than inactive firms has been noted in many previous studies of the market value and profitability of large firms.¹⁵ This table suggests that parallel analysis of the returns to IP in small and micro firms may be likely to overturn some of these results.

How do these results square with the economic theory of innovation? First of all, they do not necessarily demonstrate that there is a negative return to innovation in the long run for SMEs. It is expected that profits will be depressed in the short run when a firm is engaging in R&D and bringing new products and processes to market. The returns will come later in the form of expanded market share and higher future profitability. The figures in Table 11 are consistent with the interpretation that larger firms with bigger portfolios and a wider age distribution in their innovations and IP assets are showing this average long-term return. In contrast for SME and micro firms, who are more likely to

¹⁴ This raises questions about whether the foreign owned SMEs might be being stripped of their returns by foreign parents.

¹⁵ For a recent survey see C. Greenhalgh and M. Rogers 'The value of intellectual property to firms and society' forthcoming in *Oxford Review of Economic Policy*, Winter 2007.

have a small innovative product range (i.e. “all their eggs are in one basket”), this profile of returns shows up the burden of financing innovation and IP acquisition in the short run.

The overall comparison of density functions for active and non-active firms seen in Figure 15 suggests that IP active SMEs span a broader range of profit experience with less central tendency. This conforms exactly to the received view that innovation is risky. Four histograms are shown in Figure 16 one for each type of IP. It is notable that EPO patentees have many more firms in negative profitability. One explanation is that these firms are in a start-up, or high investment, phase of their strategy. UK patents and UK trade marks appear to have a more normal distribution, while Community trade markers appear to have slightly more negative profitability firms.

Figure 15 Profitability of IP active SMEs compared to IP inactive SMEs

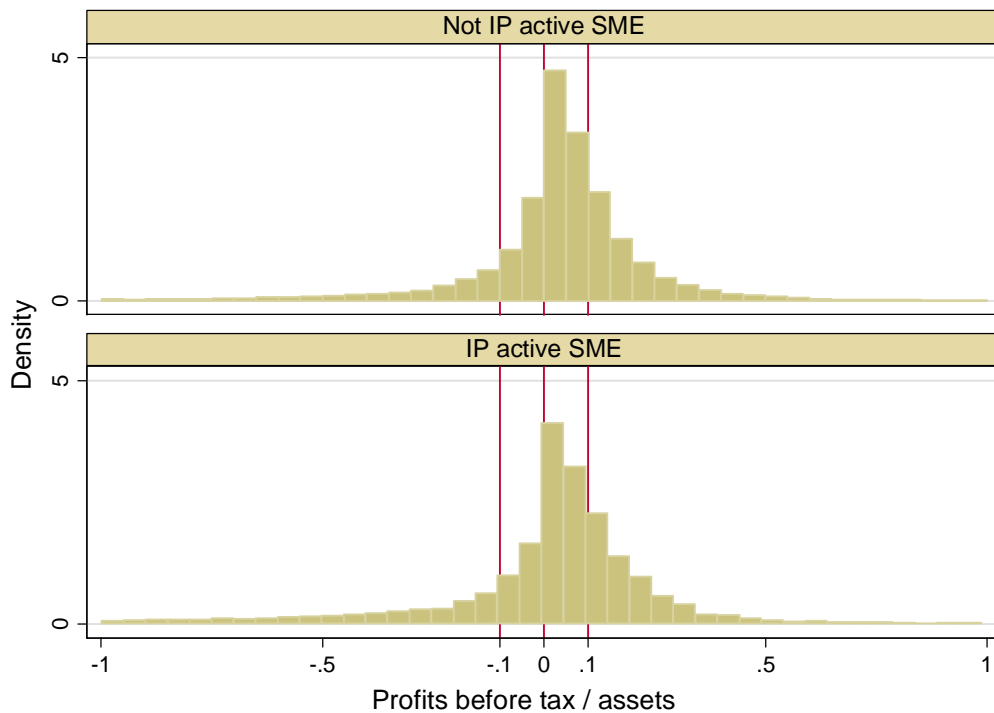
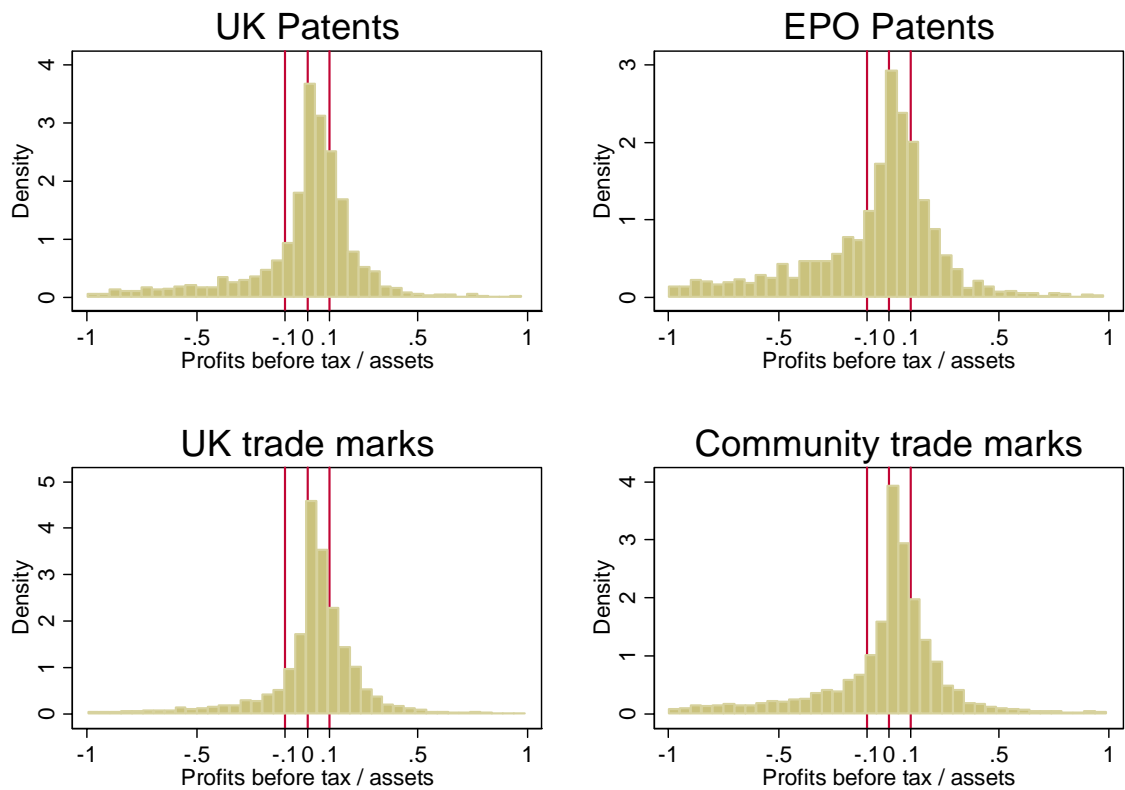
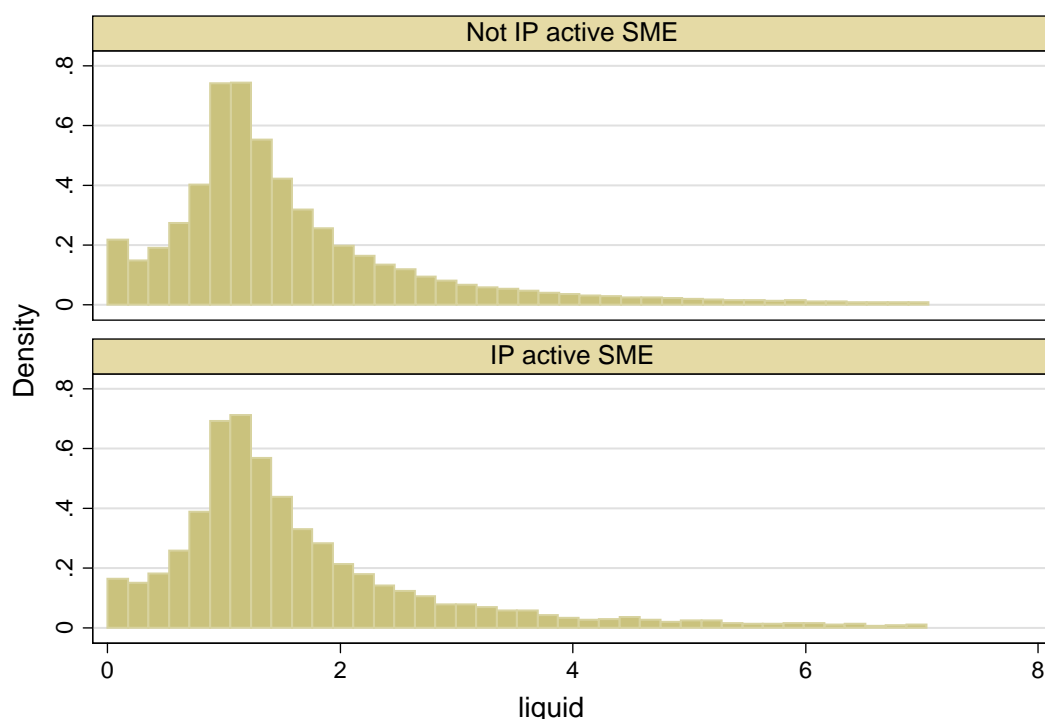


Figure 16 Profitability of IP active SMEs by IP type



Another summary measure of firm performance is the liquidity ratio – defined as the ratio of current assets to current liabilities. Relatively high values indicate that the firm is trading successfully. For FAME firms over 2001 to 2005, the median liquidity ratio is around 1.21. SMEs have a higher median (1.33), whereas micro firms are lower (1.11). For all SMEs, looking at how liquidity varies across IP type the broad pattern is that the trade marking SMEs have lower medians than patentees. Foreign owned SMEs that patent have the highest liquidity ratios. Figure 17 shows the distribution of liquidity for non-IP active and IP active firms (for 2001 to 2005) trimmed at 7.06 (the 95th percentile). One can see very little difference between the plots. The medians are 1.36 for IP active SMEs and 1.31 for non-IP active firms, again suggesting there are no major differences in liquidity.

Figure 17 Liquidity ratio of IP active SMEs and all FAME SME (2001 to 2005)



Graphs by IP active dummy

5. Propensity to use IP by firm size

We now turn to a multivariate analysis of the use made of the IP system by firms of different size. Here we focus on the intensity of IP use relative to size, as we are interested in the question of whether the total resources being employed in, say, n small firms gives rise to more or less intellectual property than does a comparable resource base employed in one firm that is n times larger.¹⁶ If size were not important then the IP intensity would be invariant across firms of different size. In our database many more firms are reporting total assets than employment. Although the intensity of innovation and IP has often been studied as a ratio to employment, to do this would decimate our sample. Instead we examine the level of acquisition of each of the four types of IP in relation to the value of firm total assets.

¹⁶ For example, there could be 10 SMEs each with £5 million in assets, or one large firm with £50 million assets. The question is do the 10 SMEs produce more IP than the large firm?

Table 12 shows the median values of IP intensity within many size classes for 2001 to 2005.¹⁷ What is immediately striking is the extent to which intensity declines with size in each of the four categories of IP assets. Whether we partition the sample into the three groups of Micro, SME and Large firms or construct a finer breakdown of the sample, IP intensity is monotonically decreasing in asset size. This result is equally true of patents and trade marks, and is unaffected by whether we are examining UK or European IP assets.

Table 12 Median IP intensity of firms of different size (2001 to 2005)

Firm size by assets	UK trade marks	CTM trade marks	UK patents	EPO patents
Large	0.030	0.022	0.036	0.029
SME	0.413	0.331	0.390	0.366
Micro	9.174	5.291	7.477	7.576
<1.3m	8.000	4.785	6.494	6.452
1.3 to 5m	0.524	0.478	0.503	0.483
>5m to 10m	0.176	0.172	0.173	0.166
>10m to 15m	0.093	0.093	0.090	0.095
>15m to 20m	0.063	0.063	0.063	0.064
>20m to 28.7m	0.047	0.046	0.048	0.047
>28.7m to 50m	0.034	0.031	0.034	0.031
>50m to 100m	0.020	0.018	0.018	0.018
>100m to 200m	0.013	0.009	0.009	0.011
>200m	0.003	0.002	0.002	0.002
All sizes	1.328	0.378	0.718	0.542

Notes: IP intensity is defined as IP per £1m of assets. Figures for Micro firms and those with assets <1.3m differ as some Micro firms with SME parents were classed as SMEs in the breakdown presented in the first three rows. All figures are for firms without foreign parents.

To explore this further and to determine the robustness of these findings we have examined the IP intensities in a multivariate analysis. Table 13 contains results of regressions using all firms reporting each type of IP asset, but trimming each sample at its 95th percentile of intensity. This is done to avoid the results being driven by small numbers of micro firms with very high intensities. The specification allows the relationship with size to be non-linear (quadratic) and also explores the role of the age of the firm, and the impact of links with a university or the impact of having a foreign parent. Three other sets of dummy variables were included for year, region, and industry. In fact the regional dummy variables were never statistically significant, indicating that raw differences by region observed above are collinear with variations in the pattern of industry and other included variables. Also the year dummies showed very little by way of trends in this short period.

¹⁷ The median was chosen rather than the mean as there is huge variation even within size classes and large outlying values dominate the mean values.

These regressions confirm the strong decline of IP intensity with firm size, although the quadratic term indicates that the rate of decline lessens somewhat with increased size. The age of the firm is also a significant determinant of intensity: the quadratic in age is first increasing, but this rise in intensity with age then lessens. Having a link with a university appears not to be important except for the case of European patents. In contrast having a foreign parent is persistently positively significant, not only for patents but also for trade mark intensity.

Table 13 **Regressions of IP intensity (2001 to 2005)**

IP Intensity:	UK trade marks	Community trade marks	UK patents	EPO patents
Log. assets	-17.67 (72.54)	-5.72 (43.07)	-12.10 (37.79)	-8.62 (34.55)
Log. assets ²	0.82 (58.36)	0.24 (36.73)	0.55 (32.03)	0.38 (29.53)
Age of firm	0.14 (14.49)	0.03 (7.40)	0.04 (4.44)	0.05 (6.52)
Age ²	-0.001 (10.07)	-0.0002 (5.11)	-0.0003 (2.72)	-0.0004 (4.99)
University link	-1.13 (0.99)	0.22 (0.23)	-0.45 (0.36)	2.45 (1.73)
Foreign parent	2.80 (18.74)	0.42 (7.34)	2.20 (14.54)	1.05 (9.80)
Constant	82.44 (18.60)	32.46 (43.14)	53.31 (43.68)	47.12 (36.04)
Sample	26,874	11,125	7,520	5,879
R ²	0.64	0.62	0.65	0.65

Notes: Dependent variable is IP per £ million assets. Reported coefficients are followed by their t ratios. All samples are trimmed to exclude intensity values above the 95 percentile. All these regressions also included year, region and industry dummies.

6. Conclusions

This report has documented the creation of a major new database that links IP activity to all UK firms. The database – called the Oxford Firm Level Intellectual Property (OFLIP) database – uses data on all UK firms over the period 2001 to 2005 and matches data on UK patents, EPO patents, UK trade marks and Community trade marks to these firms.

The report analyses the characteristics of IP active firms across a wide range of areas. It provides a series of new results that are only possible with this type of database. A summary of key findings are as follows.

General

- 6.1 The Fame database of registered companies records that the UK has around 140 thousand SMEs and two million micro firms. Just under 5% of the SMEs used one or more of the IP types in the 2001 to 2005 period. UK trade marks are the most commonly used IP type followed by Community marks, UK patents and EPO patents.
- 6.2 The ratio of SME IP activity to large firm activity varies across IP type and region (see Table 7), but for trade marks it is around 74% and for patents it is around 60%.
- 6.3 By 2005 a declining trend in patenting by large firms meant that this class of firms were overtaken by the combined set of SME and micro firms, which together contributed a larger number of patents.
- 6.4 The absolute number of trade mark applications by SME and micro firms together considerably exceeds that of all large firms in each year of the study.
- 6.5 In proportion to their asset base, SME and micro firms are more IP intensive than large firms (Table 12 and 13).
- 6.6 Even within the category of SME firms, the intensity of both patents and trade marks falls with size.
- 6.7 The share of IP active SMEs (out of all SMEs) is between 2.1 and 2.4% for the years 2001 to 2005. There is no clear evidence of a trend over these years.

Age structure of IP active SMEs

- 6.8 For UK trade marks the age structure of SMEs is very similar to non-UK trade mark active SMEs. For Community trade marks, active SMEs tend to be more likely to be 6 to 10 years of age.
- 6.9 Patenting firms are less likely to be aged between 1 and 3, but are more likely to be 5 to 10 years of age. In particular, firms of age five seem to be more patent active than expected (see Table 4).

Industry

- 6.10 The numbers of IP active SMEs varies across industry and IP type as would be expected. Table 5 indicates that SMEs in the ‘wholesale, retail and hotels’ sector are important, along with the SMEs in the ‘business sector’.
- 6.11 Of those SMEs that are IP active, most SMEs have only one or two IP publications in a year.

Geography

- 6.12 The South East region of the UK has the most patent publications by SMEs, followed by Greater London and the East Midlands (Figure 10).
- 6.13 SME trade mark activity is dominated by SMEs in Greater London, followed by South East SMEs (Figure 12).

Joint patenting

- 6.14 Joint patenting by UK firms is relatively common in UK patents (around 31% are joint), but much less common in EPO patents (around 7%).
- 6.15 Joint patenting with universities is rare (only 1.7% of UK patents by firms have a University as co-applicant), with micro firms driving this figure (3% of micro firm UK patents are with universities). Surprisingly, EPO joint patents with universities are more common (around 2.5% of all EPO patents are with universities).

Current profitability

- 6.16 Looking at the current profitability of IP active SMEs we find UK trade

markers are broadly similar to non-IP active SMEs. In contrast, Community trade markers and patentees have lower current profitability than non-IP active firms. EPO patentees have substantial numbers of low profitability firms, indicating that these are start up firm or firms making major investments.

Innovation, IP and SMEs

- 6.17 For SMEs that are IP active, section 5 indicates that they have higher IP intensity than larger firms (where intensity is defined as IP publications per million assets). Assuming that innovative activity and IP are closely linked, this suggests that SMEs have higher proportional rates of innovation.
- 6.18 These findings support the view that SMEs see value in registering their innovations to acquire IP protection. However, they do not provide evidence that SMEs are faced with a level playing field compared with large firms. The fixed costs of registering such assets, and enforcing these rights through legal action where necessary, will constitute a higher proportion of their revenues. Even so, the view that SMEs may be so financially disadvantaged, or lacking in information about IP assets, that they do not widely use these systems of protection is rejected by this study.

Future research

A companion report entitled (“An analysis of the association between the use of intellectual property by UK SMEs and subsequent performance” by M. Rogers, C. Greenhalgh and C. Helmers, 2007) provides further information on the IP-performance links. In addition, there are a large number of additional areas of research that could inform policy making on SMEs and IP including:

- An analysis of the number of patents published that were subsequently granted, and how this differed between large firms and SMEs. The database also has details of whether a patent agent was used that could further inform policy.
- The above report has not contained an analysis of patent classes or trade mark class. For example, with respect to patents, there is interest in understanding in which technology areas SMEs and micro firms are active. This could also be combined with a more detailed analysis of industry structure. A key issue is how patent classes link to industry structures, which can be analysed with the OFLIP database.
- The information on company directors could be incorporated into the tracking of IP activity. Our preliminary research suggests company directors often apply for

IP in their own name, perhaps before starting a company.

- Joint patenting activity could be further investigated. Firstly, there is interest in finding comparable international data to benchmark the UK statistics. Secondly, the relatively high joint patenting activity of micro firms, especially with UK universities is interesting. Thirdly, the high rates of joint UK patenting compared with EPO patenting is unexplained.

Appendix 1 Industry data

Table 14 IP active SMEs and average publications (non-manufacturing, 2001-2005)

Non-manufacturing industry	UK TM	Av	Com. TM	Av	UK Pat	Av	EPO patent	Av
Agriculture and Hunting	48	1.4	11	1.9	4	1.0	4	1.0
Forestry and Logging Services	2	1.0	1	1.0	2	1.0	1	1.0
Forestry and Fish Hatcheries	5	1.6	2	1.0	0	na	0	na
Mining of Coal	1	3.0	1	3.0	0	na	0	na
Extract Crude Petroleum and Gas	17	1.8	11	1.5	18	2.9	19	2.9
Mining of Metal Ores	0	na	0	na	0	na	1	1.0
Other Mining and Quarrying	1	1.0	1	1.0	1	1.0	1	1.0
Recycling	12	1.6	3	1.0	2	1.0	1	1.0
Electricity Gas Steam and Hot	5	1.6	3	2.7	3	3.3	3	2.7
Collect and Distribute Water	0	na	2	1.5	1	1.0	0	na
Construction	199	1.4	28	1.3	90	1.4	30	1.2
Sale/Mainten.of Motor Vehicle	88	1.4	30	1.4	7	1.6	7	1.4
Wholesalers	1,852	1.9	779	1.8	213	1.4	109	1.4
Retail Trade	376	1.7	141	1.6	21	4.7	13	1.2
Hotels and Restaurants	191	1.5	54	1.4	2	1.5	2	1.0
Land Transport	51	1.5	24	1.3	6	1.2	3	1.0
Water Transport	8	1.5	4	1.0	1	1.0	1	1.0
Air Transport	5	1.4	1	2.0	0	na	0	na
Supporting and Auxiliary Transport	122	1.7	46	1.3	3	1.0	3	1.3
Post and Telecommunications	106	1.9	79	1.8	33	6.1	19	2.7
Financial Intermediation	113	1.5	50	1.2	4	1.5	3	1.3
Insurance and Pensions	90	1.6	17	1.2	0	na	0	na
Activities Auxiliary to Finance	76	1.7	43	1.3	0	na	1	1.0
Real Estate Activities	137	1.5	34	1.4	11	1.2	9	1.1
Renting Machinery/Equipment	29	1.1	6	1.0	6	1.2	2	1.5
Computer and Related Activities	576	1.6	596	1.6	185	2.0	158	1.8
Research and Development	128	2.4	127	1.5	227	3.4	372	2.6
Other Business Activity	1,383	1.6	699	1.6	321	1.9	262	2.3
Public Administration	9	1.3	0	na	1	2.0	1	1.0
Education	108	1.9	23	1.4	4	1.0	0	na
Health and Social Work	200	1.7	60	1.5	24	1.9	48	1.6
Sewage and Refuse Disposal	5	1.0	1	1.0	2	1.0	1	1.0
Activities Membership Organisations	102	1.7	35	1.4	1	1.0	0	na
Recreational Cultural and Sport	327	1.7	173	1.6	17	1.5	16	3.3
Other Service Activities	319	1.5	135	1.5	50	1.1	50	1.2
Private Households with employees	2	1.0	0	na	0	na	0	na
Residents property management	1	1.0	1	1.0	0	na	0	na

Appendix 2 Comparisons with UK Community Innovation Survey (2005)

The 2005 UK Community Innovation Survey (CIS) sampled 28,000 UK enterprises with 10 or more employees and achieved a response rate of 58%, giving a usable total sample of 16, 446. The sampling base was the Inter-Departmental Business Register (IDBR) in December 2004 and firms were sampled in a wide range of sectors of manufacturing and services, but the sample excluded some primary sector categories and several public and private services.¹⁸ The survey asked about many aspects of innovative behaviour during the three years 2002-2004, including how much use was made of the IP system.

Tabulations from this database include breakdowns by firm size, with size being classified by the number of employees in three classes: 10 – 49, 50 – 249, and 250+ employees. While these categories do not map in any precise way into the classification of enterprises by size of assets used here, and the CIS data is truncated for firms employing less than 10 people and also has a narrower base of non-manufacturing firms, it was nevertheless felt to be useful to compare the general pattern of use of IP by firm size given by the two sources.

How do patenting and trade mark rates compare across firms of different size? Clearly the smaller firms in the CIS sample have lower probabilities of achieving innovations or using IP in the three-year period 2002-2004. But is the higher probability in larger firms more than or less than proportionate to their larger size?

We can construct a suitable comparison by the following exercise: If firms are evenly distributed in size across these ranges then the median firm in the 10 – 49 group is of size 30 employees, while that in the next largest group employs 150, and for the largest firms we can examine the behaviour of a typical firm employing 300 for comparison purposes. To compare performance across these size classes, we can then consider random groupings of five and ten of the smallest enterprises and calculate the probabilities of at least one use of IP occurring in these groups to compare with firms that are typically five and ten times larger.

¹⁸ The CIS 2005 database covered sectors coded 10 to 74 in the Standard Industrial Classification 2003. This range excludes agriculture, forestry and fishing, public services including defence, health and education, and personal and recreational services, all of which are included in the OFLIP database (see Table A1).

Table 15 **Community Innovation Survey data on rates of innovation and IP use**

Size of firm by no. of employees	10 – 49	50 - 249	250 +	Total 10 +
Unweighted sample	9,100	3,945	3,400	16,445
Weighted population	145,470	26,006	6,450	177,985
Product innovation ^(a) %	14	19	24	15
Process innovation ^(b) %	4	6	10	5
Use of patents %	11	23	32	
Use of trade marks %	14	28	37	
Use of copyright %	15	26	34	
Use of design reg. %	11	23	32	

Notes: CIS data are tabulated in official publications after being grossed up to the weighted population size. Product and process innovations are here limited to those reflecting (a) product new to market and (b) process new to industry. Percentages given here for use of IP reflect the authors' calculations, combining figures of IP use quoted for CIS 'innovation active' enterprises and the proportions of the size class that were classified as 'innovation active' to give proportions of the overall population that used each type of IP.

The results are as follows: for groups of five of the smallest firms on average 43% of groups would be reporting use of patents, while for groups of ten on average 67% would do so. These are much higher than the actual rates of 23% for medium sized and 32% for large firms. Similar calculations obtain for the use of trade marks, where the random groups of five and ten small firms yield probabilities of using trade marks of 53% and 78%, compared with reported values of 28% and 37% in medium and large firms. For product and process innovations the reported rates for medium and large firms are also well below the predicted rates for random clusters of small firms. Thus we see that in both these types of IP use, the intensity of use in relation to their employment size is highest in the smallest firms.

How do these findings compare with those we have generated in our study? Before commenting, we note that the range of industries surveyed in the CIS is considerably narrower than that used in our database and omits some primary and service sectors that have not been very innovation intensive historically or recently (see Table 14 for details of activity rates in the first three and last nine rows, all these industries are omitted from CIS). Second the moderate response rate of 58% may conceal the fact that non-respondents were more likely to be non-innovative.

The particular questions about the use of patents and trade marks are quite general and do not obviously restrict respondents to recording only those IP assets that were new

within the three year survey period. Rather it may be that these responses were reflecting the firms' historic stocks of patents and trade marks. With all these factors in mind it is thus not surprising to find higher revealed rates of patent and trade mark use in the CIS data. What our study points out is that the use of a wider population base can change perceptions about IP activity in the short run. Even so the finding from the CIS data that IP activity is proportionally higher among smaller firms is consistent with our analysis of IP intensity.

Appendix 3 Brief explanation of IP types

A trade mark is any ‘sign’ that can be used to distinguish a product or service. A sign can be any word(s), graphics, figures, images or similar that can act as a distinguishing feature. Trade marks can also be distinctive shapes, colours or sounds, although rather few such applications have been granted. To obtain a trade mark it must be a distinctive mark for your company and not be deceptive or contrary to law or morality.

For a UK company or individual there are two methods of obtaining trade mark protection in the UK. The cheapest method is to apply for a UK trade mark (UKTM) from the UK Patent Office. This will cost around 300 euros. An alternative route is to apply for a Community Trade Mark (CTM). The CTM was introduced in 1996 and is more expensive at around 2000 euros, but a CTM covers all countries in the EU. In both cases, applications for trade marks are examined and then published, allowing a period of time for others to object, before full registration.¹⁹ For UK trade marks we count publications; for CTMs we count registrations. The initial registration lasts for 10 years, at which time a renewal fee is payable (300 euro for UKTMs and 2500 for CTMs). Each trade mark application has to specify a class in which the trade mark is to be used. Multiple classes per single application are allowed, although there is a surcharge for more than three classes.

A patent protects an invention. The basic requirements are that the invention is:

- New
- Has an “inventive step” (meaning it is not obvious to someone in the industry)
- Be capable of being made or used in industry.

Certain categories of invention are excluded, such as mathematical or scientific discoveries.

Protection in the UK can be sought via either the UK IP Office or the European Patent Office. A UK patent costs around £200 and may take around 2 to 3 years from application to grant. If an application meets a set of initial requirements the patent is “published” 18 months after the date of application. It is these “publications” that we count in this report. The cost of an EPO patent varies according to the route used and the designated countries. A simple case might be Euro 4,000. For both UK and EPO patents use of a patent attorney, which is generally thought to be worthwhile, will increase costs considerably.

¹⁹ Some trade mark applications are not registered due to invalid claims or oppositions. The UK Patent Office currently states that around 90% of trade mark applications are registered within 8 months (<http://www.patent.gov.uk/tm/howtoapply/faq.htm>). For Community trade marks, out of the 57,373 applications in 2000 there were 11,495 oppositions. Assuming half of oppositions resulted in registrations the approximate success rate is 90% also. The delay in getting a Community trade mark appears somewhat longer than a UK patent at around 15 months (based on 2004 data at <http://oami.eu.int/en/office/stats.htm>).