The importance of patents and other formal intellectual property in comparison with informal protection methods

Bronwyn Hall[a], Christian Helmers[b], Mark Rogers[c,d], Vania Sena[c]

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[a] UC Berkeley, University of Maastricht
[b] Universidad Carlos III de Madrid
[c] Aston Business School, Aston University
[d] Harris Manchester College, Oxford University

Contact: christian.helmers@uc3m.es

Executive Summary

This report provides an analysis of the determinants of a firm´s patenting decision and assesses potential implications of the choice on its innovative performance measured in terms of turnover and employment growth due to innovation. The analysis relies on a new integrated dataset that combines a range of data sources into a panel at the enterprise level. Our findings suggest the following conclusions and policy implications with regard to (a) future data collection, (b) a firm's decision to patent or to rely on informal IP and (c) the relation between this decision to patent and (innovative) performance.

(a) Data

A significant improvement in conducting the Fifth Community Innovation survey (CIS 5) over the Fourth (CIS 4) was the large overlap in samples between CIS 4 and 5 in comparison with CIS 3 and 4 (see Table 2). Such overlap is a necessary condition for researchers' abilities to construct longitudinal datasets. Despite our efforts to construct a panel containing firms observed over several time periods, the number of firms sampled in all three waves was too small to use statistical methods that rely on variation in the data over time to account for unobserved heterogeneity across firms. We would, therefore, welcome the incorporation of such analytical concerns in the construction of future CIS sampling frames in the UK.

(b) Determinants of a firm´s choice between formal and informal IP, in particular patents and secrecy

Our descriptive analysis shows that about 53% of firms in the sample conduct some form of research and development. However, only about 22% of firms report having a product innovation and only 14% a process innovation during a three year period. Only about 30% of firms report any form of innovation. Strikingly, we find that only 1.3% of firms in the sample patent, and even among firms that conduct R&D, only 2% patent. In particular, the share of patenting firms is much lower than what one might expect given that nearly 24% of firms report product innovations.

There are also large differences in the share of patenting firms across sectors. Whereas only 0.4% of non-manufacturing firms patent, over 15% of in the R&D services sector do so.

The CIS data suggests that the overwhelming share of firms does not consider patents and other forms of formal IP to be an important mechanism to protect inventions. Only between 2.8% (CIS 3) and 5.0% (CIS 5) of firms regard formal IP as crucial. Within the formal IP category, trademarks appear to be considered the most important IP right. Informal IP mechanisms are regarded as more essential by firms than registered and unregistered IP (copyright). On average, 66% of firms report that they do not use any of the four 'alternative' mechanisms. Secrecy, lead-time and confidentiality appear similarly important to firms, whereas complexity in design appeals less to firms as a way of protecting innovation.

As might be expected, the importance attributed to formal IP differs greatly depending on whether a firm innovates. Nearly 92% of firms that do not report any product innovation regard patent protection as unimportant, whereas only slightly less than 30% of firms that have a product innovation do not regard patents as important to protect their innovation. Looking at secrecy as a mechanism to protect innovations, only 38% of product innovators report not relying on it whereas 78% of non-product-innovating firms do so.

The share of firms regarding formal IP as important is substantially larger for patenting than for non-patenting firms. About a quarter of patenting firms regard registered IP as crucial and nearly 60% of patenting firms regard patents as a crucial mechanism to protect innovations. Patenting firms are also seen to rely much more heavily on informal protection mechanisms than non-patenting firms; almost 40% of patentees consider secrecy as crucial whereas only 9% of non-patenting firms do so. This illustrates that, in practice, firms are likely to consider a mix of different appropriability mechanisms, but also that many firms simply ignore IP altogether, either because they do not innovate or because they do not find it useful.

There is considerable variation across sectors in terms of the importance allocated to informal IP, both for patenting and non-patenting firms. In particular, firms in the R&D services sector attribute by far the highest importance to informal mechanisms.

Larger firms report a considerably higher reliance on any type of appropriation mechanism, including both formal and informal IP. This suggests that larger firms manage their innovations more actively and exploit the whole available range of IP protection mechanisms, but it also suggests there may be fixed costs to developing an IP management policy that are easier to support with larger sales and profits.

Regarding the size of the inventive step, formal IP in the form of patents, trademarks and registered designs is used the most by firms that produce an innovation that is 'new to the market'. This pattern also bears out in the actual patent data; there are more firms with innovations that are 'new to the market' which hold patents than firms whose innovation is only 'new to the firm'. The distributions for 'alternative' protection mechanisms including secrecy reveal that firms that have product innovations that are new to the market also report using the 'alternative' mechanisms the most.

The multivariate analysis of the choice of patenting and/or secrecy for innovating firms finds that the importance attributed to patents as a mechanism to protect innovations is positively associated in a statistically significant way with a firm's propensity to patent. A one unit increase in the rating of patent importance increases the probability of patenting by about 1.5%, which is a large effect given the overall patenting level of about 6% for this sample. Secrecy, in contrast, has no statistically significant association with observed patenting behaviour.

The same analysis shows that many other factors have a positive impact on the probability of choosing to patent an innovation. First, product innovators are more likely to use patents than process innovators, as predicted. Second, larger firms (measured as employment), older firms, and firms that are members of a group are more likely to patent, undoubtedly reflecting the ability to spread fixed costs. In addition, firms that register a trademark are more likely to patent, suggesting that firms that are more familiar with the IP system in general tend to use all means of protection and are probably able to spread costs across them. Third, the technology level of the firm increases the patenting probability; high-technology firms, firms that report some form of R&D during the reference period and the share of a firm's employees that possess a science and/or engineering degree, are positively correlated with a firm's patenting propensity. Fourth, exporters are more likely to patent, reflecting their need to compete on world markets.

Controlling for all these other variables, industry-level effects are also important. These are measured in two ways: as 2-digit level differences in the mean patenting probability and, by including 3-digit industry-level variables, a market concentration measure (Herfindahl index) constructed based on firms' employment data and R&D intensity measured as the ratio of intramural R&D spending and employment. Firms in concentrated markets patent significantly less than other firms, suggesting that they may have other informal ways of protecting their innovations. R&D intensity is only (weakly) statistically significant when the 2-digit sector-level effects are not included which suggests that it captures some of the sector-specific unobservables relevant for a firm's choice to patent, beyond those from its own R&D behaviour.

(c) The use of IP protections and (innovative) performance

With regard to the association between patenting and innovative performance, our findings suggest that there is little correlation between a firm's performance in terms of turnover due to innovative products 'new to the firm' and the importance it attaches to the different protection mechanisms. In contrast, we find evidence that firms that attach high importance to patents and/or secrecy appear to perform better in terms of turnover due to innovation 'new to the market'. The difference is particularly pronounced with regard to the use of informal protection mechanisms as only 18% of firms reporting that they do not employ informal mechanisms achieve ≥25% turnover due to an innovation that is 'new to the market' whereas 31% of firms that report these mechanisms as crucial for their business achieve this high a turnover due to new products. Overall, this suggests that firms that regard patents and/or secrecy as important, and that have a product innovation that is 'new to the market', outperform firms that also have an innovation that is 'new to the market' but that do not use patents and/or secrecy.

Regression results that control for other determinants of innovative performance, such as size, age, exporting and industry, find a strong statistically significant association between a firm's decision to patent and its innovative performance measured as the share in turnover due to innovations that are 'new to the market', but no association for innovations that are 'new to the firm'. Other things equal, being a patenting firm is associated with an increase of about 5% in the share of sales from products new to the market and a significant increase of 0.2% in employment growth between 1998 and 2006.

1. Introduction

One of the most puzzling findings in the empirical analysis of firms' patenting behaviour is the low proportion of patenting firms in the population of registered companies. Even in high-tech manufacturing sectors, which arguably produce the most patentable inventions, the share of patenting firms in the UK does not surpass 10% (Helmers *et al*., 2011). Restricting the high tech sector to R&D-doing firms that innovate increases the share only to 16% (Hall and Helmers 2011). Moreover, shares of patenting firms differ dramatically across sectors; for example in the UK, manufacturing of chemicals and chemical products has a share of nearly 10% of patenting firms whereas manufacturing of tobacco products effectively has close to no patenting firms (Helmers *et al*., 2011). This suggests that (a) firms may not patent patentable inventions and (b) this behaviour differs across firms within industries as well as (c) across industries.

This report provides an analysis of the determinants of a firm's choice between formal, registered intellectual property (IP) in the form of patents and unregistered informal knowledge protection mechanisms, such as secrecy and lead-time. It investigates the circumstances under which firms may decide not to patent patentable inventions and explores the determinants of differences in patenting propensities across firms within and across sectors. In addition, this report provides some empirical evidence on the impact of a firm's choice on its innovative performance.

The analysis is based on a new firm-level dataset that combines information from a range of different sources. This dataset contains not only detailed information on firms' self-reported innovation activities from the UK Community Innovation Survey (CIS), but also on firms' actual patent and trademark holdings. The combination of the different data sources allows us to overcome a number of problems that have plagued existing work on the determinants of a firm's patenting propensity. If only patent data at the firm-level are available without information on a firm's innovative activities, strong assumptions regarding firms' underlying innovative activities are required in order to make inference on a firm's patenting propensity. However, even when data on innovation input such as R&D are available, it is empirically difficult to determine whether patenting propensities differ due to differences in unobserved productivity, i.e. the way R&D is translated into patentable innovations, or due to genuine differences in patenting propensities (Brouwer and Kleinknecht, 1999). The availability of information on innovation output (and its 'quality'), together with data on a firm's actual patent applications, allows us to overcome this problem and to assess the determinants of a firm's decision to patent.

In a chapter of the Handbook of the Economics of Innovation, Mairesse and Mohnen (2010) review the extensive existing research based on the CIS data and conclude with a number of recommendations for future research, among which "merge innovation data with other data" and "create longitudinal datasets" stand out. The research presented in this report provides progress along these lines as we combine three CIS waves with patent and trademark data, a business survey as well as census data for the UK.

The results of our analysis underscore the trade-off that firms face in their patenting decision. Formal IP provides advantages and drawbacks and whether the advantages outweigh the drawbacks depends on a range of exogenous factors (e.g. some types of inventions are less patentable) and potentially endogenous factors (e.g. a firm's perception of the importance of IP) which help to explain the enormous variation in patenting propensities across firms and industries. In this report, we point to a number of factors that we find to be associated in a robust way with a firm's decision to patent or to opt for informal IP in the form of secrecy.

This report is organized as follows. Section 2 briefly summarises the relevant literature that is based on the analysis of CIS data. Section 3 describes the structure and content of the dataset used for the analysis. Section 4 provides descriptive evidence on our principal research questions. Section 5 outlines our empirical approach and Section 6 discusses the corresponding results. Section 7 summarises the main findings and offers some policy-relevant interpretations.

2. Literature

While we discuss the relevant literature at length in the first report of this project (Hall *et al*., 2011), we briefly review below a number of relevant studies using CIS data. This is useful to frame our analysis within the existing research and to compare our results presented in Section 5 with the existing findings.

Brouwer and Kleinknecht (1999) is one of the first papers based on the CIS 1 data (for Holland) that studies the determinants of a firm's decision to patent. The Dutch CIS 1 data also contains information on firm's patent holdings, which allows Brouwer and Kleinknecht to investigate the determinants of a firm's actual patent holdings. They find firm size, a firm's sales of innovative products, and R&D collaboration agreements to be positively correlated with a firm's patenting propensity. Also firms in high-tech sectors appear to have higher patenting propensities. Their findings also hold when the authors consider patent applications that were filed two years before the CIS reporting period, a fact that might be explained by high persistence in a firm's patenting activity. Arundel (2001) uses CIS 1 data for seven European countries to show that the propensity to use secrecy relative to patents falls with firm size (measured as R&D expenses and employment) for product innovations, while the association is much weaker for process innovations. Arundel also finds cooperation in R&D to decrease a firm's propensity to rely on secrecy relative to patents. Farooqui (2009) uses the three UK CIS waves (CIS 3, 4, and 5) to investigate the importance of formal IP and secrecy to firms. He restricts his sample to firms employing workers with a degree in science and engineering subjects and also that report positive contemporaneous R&D expenditure. Farooqui (2009) also adds data on firm characteristics from the UK enterprise census, although Farooqui does not have data on intellectual property. This means that he uses a firm's responses to the question on the importance of different protection mechanisms as the dependent variable (he uses the score for registered IP, as well as the difference between secrecy and registered IP). He treats the standardised responses as a continuous variable, and estimates a linear postcode-level fixed effects model. Farooqui's findings confirm the results by Brouwer and Kleinknecht (1999) and Arundel (2001). He finds product innovators to rely more on formal IP than process innovators and firms in high-tech sectors and those that are part of multinational companies to attribute more importance to formal IP. Farooqui (2009) also looks specifically into the subset of firms that engage in innovation-related collaboration. He finds these firms to have a strong preference for informal protection mechanisms over formal IP.

Similar to Farooqui (2009), Pajak (2009) uses firms' responses on the importance of different protection methods to evaluate the determinants of a firm's choice between patenting and secrecy. Pajak uses the French CIS 4 data and limits his sample to small firms that report a product and/or process innovation.[1] His main variables of interest in determining a firm's choice are firm size and the size of the inventive step. In the French CIS, the answers regarding protection mechanisms are only binary variables; this means Pajak estimates a bivariate probit to model the choice between patents and secrecy. A firm's size is measured as employment and the size of the inventive step by using the 'new to the firm'/ 'new to the market' distinction, the % in turnover due to the innovation, as well as a firm's responses concerning the effect of the innovation for the firm. As expected, Pajak finds that the use of patents is increasing with a firm's size. Moreover, for his sample of small firms, Pajak finds that inventions characterised by a smaller inventive step are more likely to be patented, which he considers in line with the theoretical predictions by Anton and Yao (2004).This empirical finding should be interpreted with caution, however, as it might be spurious and caused by the fact that smaller inventive steps are more frequent in the data.

Heger and Zaby (2010) exploit data from the Mannheim Innovation Panel (which represents the German CIS) for 2005 which offers firms' self-reported innovation measures as well as data on their patent holdings. They limit their analysis to firms reporting product and/or process innovations which leaves them with a cross-section of 740 firms. Heger and Zaby (2010) present a theoretical model that predicts that firms prefer secrecy when they have a considerable advantage relative to competitors, but patent when the technological lead is small. The intuition is that the information disclosure required by a patent is only worthwhile when the protection effect of a patent is large enough. While the cost of disclosure increases with the technological lead, the protection effect remains constant. This means that for firms with a larger technological lead, costs associated with disclosure outweigh the benefits from patenting. This relationship, however, is not directly confirmed by the data. Instead, Heger and Zaby (2010) find that a firm's propensity to patent increases in its technological lead in industries in which reverse engineering is relatively easy. That is, if a firm is highly successful but threatened by low cost imitation, it is more likely to patent because it has more to lose. Hussinger (2006) investigates the question of the impact of a firm's choice between patenting and secrecy on its performance (measured as sales due to new products) using the Mannheim Innovation Panel (which represents the German CIS 3) to which she adds patent filings at the German Patent and Trademark Office. She limits the sample to R&D conducting firms that report a product innovation. Hussinger finds only patenting to be associated in a statistically significant and positive way with a firm's sales due to new products.

All studies discussed above, apart from Farooqui (2009), rely on cross-sectional data using only a single CIS. Some of the studies merge in patent data at the firm level. However, accounting for unobserved heterogeneity at the firm level is difficult in the absence of longitudinal variation.

[1] The main reason for limiting the sample to small firms is the need to establish a correspondence between a firm's reported size of the inventive step and the reported innovation. This correspondence may be diluted for large multiproduct firms, whereas it may appear to be more reasonable to assume that small firms only have a single innovation.

3. Dataset

Components

The dataset that we have constructed for the analysis consists of the following six components available at the ONS Virtual Microdata Laboratory. These are all linked by the unique enterprise business register number:

1) **Business Structure Database (BSD)**: the dataset is derived from the Inter Departmental Business Register (IDBR) and provides longitudinal business demography information for the population of businesses in the UK. We use information on a company's industrial classification (SIC 92), employment, turnover, as well as incorporation and market exit dates from the BSD.[2]
2) **Annual Respondents Database (ARD2)**: the ARD2 is constructed from the microdata collected in the Annual Business Inquiry (ABI) conducted by the ONS (see Robjohns, 2006). The stratified survey sample is drawn from the IDBR.[3] We use the following variables from the ARD2: gross value added (derived) and exporter status.
3) **UK Community Innovation Survey (CIS) 3, 4, and 5**: the CIS is a stratified sample of firms with more than 10 employees drawn from the IDBR. The CIS contains detailed information on firms' self-reported innovative activities.[4] We use three surveys: CIS 3 which covers the period 1998-2000, CIS 4 which covers 2002-2004 and CIS 5 which covers 2004-2006. The sample frames differ for the three CIS waves both in terms of size and industry coverage. For CIS 3, the sample frame consists of 19,625 enterprises with responses from 8,172 enterprises (42% response rate); CIS 3 covers both production (manufacturing, mining, electricity, gas and water, construction) and services sectors whereas the retail sector was excluded. CIS 4 has the largest sample size out of the three CIS waves with a sample frame of 28,355 enterprises and responses from 16,446 enterprises (58% response rate); it also includes the following sectors: sale, maintenance & repair of motor vehicles (SIC 50); retail trade (SIC 52); and hotels & restaurants (SIC 55). CIS 5 was answered by 14,872 firms which corresponds to a response rate of 53% (Robson and Haigh, 2008). It covers the same industries as CIS 4 with the addition of SIC 921 (motion picture and video activities) and 922 (radio and television activities).
4) **Patent data**: we use a match of UK patents obtained from Optics and EPO patents (designating the UK and obtained from EPO's Patstat database, version April 2010) with the

[2] The definition of market exit is problematic. It is not possible to identify whether a firm has ceased trading or if it has merely undergone a change in structure that leads to its original reference number becoming extinct.

[3] The stratification sample weights are as follows: businesses with (a) <10 employees 0.25, (b) 10-99 employees 0.5, (c) 100-249 employees all or ≥ 0.5 depending on industry, and (d) >250 employees all. Moreover, if a firm with <10 employees is sampled once, it is not sampled again for at least three years.

[4] The survey structure follows the Oslo Manual (OECD, 1992). See Mairesse and Mohnen (2010) for a detailed discussion of the CIS data.

IDBR. The patents-IDBR match was carried out by the ONS/UKIPO using firms' names as patent documents lack unique firm identifiers.[5] Since the matched data is based on the IDBR, it has population coverage and covers all patents filed at UKIPO, WIPO (designating the UK through PCT route) and EPO (designating the UK through the EPC route) by firms registered in the UK over the sample period.

5) **Trademark data**: trademarks were matched to the IDBR by the ONS/ UKIPO. The data contains UK and Community (OHIM) trademarks held by firms registered in the UK during the sample period.
6) **Business Enterprise Research & Development expenditure (BERD) data:** The ONS conducts an annual survey based on the Frascati Manual to measure R&D expenditure and R&D-related employment in the UK. The BERD survey uses a relatively small stratified random sample, which means that the overlap with CIS is low. For this reason, we use the data only to construct industry-level (SIC 3-digit) R&D intensity figures.

The BSD, ARD2 and CIS data were cleaned and modified/ adapted in order to combine them into a single integrated dataset. In particular, the structure of CIS 3 differs considerably from CIS 4 and 5, which required a number of changes to make the different datasets compatible and consistent.

We conduct the analysis at the 'enterprise' level where an enterprise comprises all legal units under common control.[6] Hence, an enterprise may consist of multiple legal units, although the overwhelming share of enterprises is single legal units. An enterprise is the smallest business unit for which the ONS collects a full set of statistics. However, an enterprise may also contain several 'local units' which can, for example, be production sites. The patent and trademark data is available only at the enterprise level which motivates us for consistency to conduct our analysis at the enterprise level. When necessary, we aggregated data at the local unit level up to the enterprise level.

Structure of dataset

In principle, the linked dataset is a firm-level panel containing detailed information on firm characteristics, innovative activities as well as patent and trademark filings over the nine-year period 1998-2006. Due to the stratified nature of the sampling of the CIS and ARD data and a changing sampling frame over time, the panel is highly unbalanced. In this report, we focus on the sample of firms covered by the CIS. Hence, we drop all firms from the integrated dataset that have not been sampled in at least one of the three CIS waves. This means that in this report, we use the BSD, ARD2, BERD, and patent and trademark data only to enrich the dataset available from the CIS.

Since the CIS refers to several years (CIS 3 to 1998-2000, CIS 4 to 2002-2004 and CIS 5 to 2004-2006), we collapse the panel to three time periods which cover the entire period 1998-2006 (with the exception of 2001). All continuous variables from the BSD and ARD2 are averaged over each of the

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[5] For a detailed description of the methodological challenges see Thoma *et al*. (2010) and Helmers *et al*. (2011).

[6] The ONS defines an enterprise as follows: "The enterprise is the smallest combination of legal units that is an organizational unit producing goods or services, which benefits from a certain degree of autonomy in decision-making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more locations. An enterprise may be a sole legal unit."

three CIS reporting periods, whereas we use the maximum value for discrete variables from the BSD, ARD2, and the registered IP data. This implies, for example, that the patent dummy variable measures whether a firm has taken out at least one patent during a three-year CIS reference period. In principle, this produces a panel of firms; in practice, however, few firms appear in all three CIS waves. In fact, the overwhelming number of firms is sampled only once (see Table 2). This means that for the most part of the analysis, we treat the data as a pooled cross-section although we also exploit the panel structure for the subset of firms for which there are at least two observations in time available.

Table 1 shows the number of firms by CIS wave. Most observations are available for CIS 4 (42% of sample) whereas CIS 3 (20% of sample) is only about half the size of CIS 4. There are a total of 38,760 observations in the sample.

Table 1: Sample size by year

	CIS 3	CIS 4	CIS 5	Total
Number of observations	8,070	16,099	14,591	38,760
%	20.82	41.54	37.64	100

The data for the three CIS waves were made compatible to form a panel. Table 2 shows the structure of the resulting panel used in the descriptive analysis presented in Section 4. The shaded rectangles indicate the availability of data. There are only 541 firms that have been sampled in all three CIS waves. The largest overlap between CIS waves exists for CIS 4 and 5 with a total of 6,504 firms. Overall, there are 7,765 firms (25% of sample) that appear in at least two CIS waves. Therefore, despite the panel dimension of the data, there are relatively few units that we observe multiple times which severely limits our ability to rely on variation over time in our analysis.[7]

Table 2: Panel structure (full sample)

Number of firms	%	CIS 3	CIS 4	CIS 5
541	1.78	■	■	■
481	1.58	■	■	
6,504	21.36		■	■
239	0.78	■		■
6,809	22.36	■		
8,573	28.15		■	
7,307	23.99			■
30,454	**100**			

Note: Grey-shaded rectangles indicate data are available.

Table 3 shows the distribution of firms across aggregate sectors over the three CIS samples.[8] The table has been produced using sampling weights to account for the stratified nature of the CIS

[7] Obviously Table 2 says nothing about item non-response, i.e. the number of firms that report sufficient data to be included in any analysis is lower than the numbers indicated in Table 2.

[8] Definition of high-tech and medium-tech according to OECD.

samples. The table disguises the fact that due to the different sampling frames across time, SIC 92 is only covered in CIS 5 and SIC 50, 52, and 55 are excluded from CIS 3. This explains some fluctuations in shares shown in Table 3 across CIS waves and the relatively larger share accounted for by manufacturing firms in CIS 3. There are relatively few firms in high-tech sectors and R&D services, which account on average for only around 1.3% of firms.

Table 3: Sample distribution across sectors

Sector	CIS 3	CIS 4	CIS 5	All
	%	%	%	%
High-tech	2.68	1.59	1.53	1.85
Medium-tech	6.91	4.50	4.19	5.01
Other manufacturing	25.78	15.51	14.57	17.83
Non-manufacturing	63.94	76.31	78.87	74.05
R&D services	0.70	2.09	0.85	1.27

Notes:

(1) Sampling weights used.

(2) High-tech: pharmaceuticals SIC 2423; aircraft & spacecraft SIC 353; medical, precision & optimal instruments SIC 33; radio, television & communication equipment SIC 32; office, accounting & computing machinery SIC 30;

(3) Medium-tech: electrical machinery & apparatus SIC 31; motor vehicles, trailers & semi-trailers SIC 34; railroad & transport equipment SIC 352 & SIC 359; chemical & chemical products SIC 24 (excl. SIC 2423); machinery & equipment SIC 29;

(4) R&D services: SIC 73.

Table 4 shows the size distribution of firms across the different CIS waves. The size definition is as follows: small firms 11-49 employees (micro firms with ≤10 employees are not included in the CIS); medium-sized enterprises have 50-249 employees; large firms ≥250 employees. The data shown in Table 4 uses sampling weights in order to account for size-based stratification of the sample. The table shows that over 80% of firms in all CIS waves are small and less than 4% are large (Table A1-1 in the Appendix contains the corresponding number of firms).

Table 4: Sample distribution across firm size categories

Firm size category	CIS 3	CIS 4	CIS 5	All
	%	%	%	%
Small	82.44	81.34	82.06	81.90
Medium	13.00	14.76	14.32	14.14
Large	4.56	3.90	3.62	3.97

Notes: Sampling weights used.

4. Descriptive analysis

This section provides a descriptive analysis of a firm's innovative and patenting activities, as well as descriptive evidence on the determinants of a firm's choice between formal IP, mostly in form of patenting and informal IP, with a focus on keeping an invention secret. The descriptive analysis also tells us something about the relation between a firm's patenting decision and its innovative performance. The statistics below are based on weighted data to account for the stratified sampling used in the CIS. [9] The Appendix shows some descriptive statistics based on unweighted data which also reveal the number of available firms used to produce the descriptive statistics shown in this section.[10]

Table 5 shows the distribution of innovative firms in the three different CISs. The table shows that on average, around half of all firms conduct some form of research and development. The share of firms conducting some form of R&D increases considerably across time, with only 39% in CIS 3 and 62% in CIS 5. Shares of product and process innovators are much lower. Only about 14.5% of firms report to only have a product innovation and only 5.4% a process innovation. These shares vary substantially across the different CISs, with the highest share of product innovators found in the CIS 4 sample whereas the highest share of process innovators is in CIS 3. Moreover, the table suggests that slightly less than 10% of firms produce both product and process innovations. One can deduce from these figures that about 70% of firms do not produce any product or process innovation.[11] This changes when we condition on a firm conducting some form of R&D. Conditional on conducting R&D, about 25.5% of firms come up with a product innovation only, 9.5% with a process innovation only and 16% with both.

Table 5: Distribution of Innovative Activities

	Any R&D (% yes)	Only product innovation (% yes)		Only process innovation (% yes)		Product & process innovation (% yes)		Patenting firms (% yes)	
			Any R&D		Any R&D		Any R&D		Any R&D
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CIS 3	39.06	11.16	23.00	7.85	16.79	7.76	17.47	1.56	2.95
CIS 4	54.18	16.30	29.00	5.80	10.89	10.83	18.87	1.64	2.50
CIS 5	62.07	15.21	23.66	3.29	5.36	8.56	13.59	0.93	1.34
All	**53.20**	**14.54**	**25.46**	**5.39**	**9.50**	**9.18**	**16.29**	**1.35**	**2.08**

Table 5 also shows the share of patenting firms in the CIS samples. Firms are considered to patent if they have filed at least one patent application during the reference period of the CIS (CIS 3: 1998-2000; CIS 4: 2002-2004; CIS 5: 2005-2006).[12] The most striking feature of the data displayed in Table 5, as already mentioned in the Introduction, is the low share of patenting firms even when

[9] Weighting is necessary to produce statistics that are representative of the population of firms due to the stratified nature of the sample. The weights used in the descriptive analysis correspond to the inverse sampling proportion in each stratum, which corresponds to the number of firms in the population divided by the number of responses in each stratum.

[10] When using weighted data, showing the underlying numbers of firms would be misleading and are thus omitted from the tables shown in Section 4 but some additional information can be found in Appendix 1.

[11] Shares of non-innovating firms are obtained by subtracting the sum of product, process innovators only and product & process innovators from 100, e.g. looking at Columns (2), (4), and (6): 100-(14.54+5.39+9.18)=70.89.

[12] The reference period of CIS 5 was reduced to two years to avoid double counting due to the overlap with CIS 4.

conditioning on firms' R&D activities. The data suggest that about a fifth of firms produce a product innovation, which may, in principle, represent a patentable invention. Yet, the average share of patenting firms at 1.35% is much lower than what one might expect given that around 30% of firms report some form of innovation. These figures on firms' patenting activity are similar to the evidence for the UK provided by Helmers *et al.* (2011) and Rogers *et al.* (2007), although the shares of patenting firms in the CIS sample appear to be even lower.

Table 6 shows a cross-tabulation of registered IP and product and process innovators. It shows that over 90% of patenting firms report some form of innovation, where about 46% report a product innovation only and about 10% a process innovation only. In contrast, among firms that have not taken out a patent during the period of analysis, shares of product and process innovators are much lower, 14% and 5% respectively (these figures are nearly the same as those in Table 5 because the overwhelming share of firms does not patent). Interestingly, over 70% of firms that do not patent report no innovation during the CIS reference period.

Table 6: Distribution of patenting and innovative activities

	No patent	Patent
% Process innovation only	5.34	10.29
% Product innovation only	14.24	45.85
% Product & process innovation	8.81	36.56
% No innovation	71.61	7.30

Table 7 shows the distribution of product and process innovators as well as patenting and trademarking firms across aggregate sectors. The shares of product and process innovators are considerably higher in high-tech and the R&D services sectors. The same applies to patenting and trademarking firms. Whereas in the R&D services sector about 16% of firms patent, the share of patenting firms in services is less than 0.5%. Table 7 thus shows that the low overall shares of product and process innovators as well as patenting and trademarking firms are mostly accounted for by the services sector. This is little surprising considering the limited patentability of the overwhelming share of services provided by firms in the services industry.

Table 7: Distribution of innovative activities across sectors

Sector	**Product only**	**Process only**	**Product & process**	**No innovation**	**Patent**	**TM**
	%	%	%	%	%	%
High-tech	35.40	7.47	23.94	33.19	8.33	5.28
Medium-tech	25.52	6.27	17.23	50.98	6.17	5.33
Other manufacturing	15.18	9.19	12.64	62.99	2.05	4.07
Non-manufacturing	13.19	4.21	7.12	75.48	0.44	2.26
R&D services	23.49	22.17	27.50	26.84	15.65	7.95
All	14.54	5.39	9.18	70.89	1.35	2.86

Notes:

(1) A χ^2 test suggests that the shares are statistically significantly different at the 1% level.

(1) High-tech: pharmaceuticals SIC 2423; aircraft & spacecraft SIC 353; medical, precision & optimal instruments SIC 33; radio, television & communication equipment SIC 32; office, accounting & computing machinery SIC 30;
(2) Medium-tech: electrical machinery & apparatus SIC 31; motor vehicles, trailers & semi-trailers SIC 34; railroad & transport equipment SIC 352 & SIC 359; chemical & chemical products SIC 24 (excl. SIC 2423); machinery & equipment SIC 29;
(3) R&D services: SIC 73.

Table 8 explores whether a firm's innovative and formal IP activity is also related to whether a firm is part of a business group and whether it is foreign-owned. The table shows that slightly more than 40% of firms that are part of a business group report some form of innovation, which is about 14 percentage points higher than for standalone firms. More strikingly, the share of patenting firms that are part of a business group is slightly more than 5%, which exceeds by far the share of patenting standalone firms of not even 1%. This echoes findings for a sample of large European firms by Belenzon and Berkovitz (2010) which also suggest that firms that are part of a business group tend to patent more. Rather surprisingly, there are no such strong differences between foreign-owned and domestic companies. For example, the share of patenting foreign firms is 1.4% which is nearly the same as the share of patenting domestic firms (1.3%).

Table 8: Distribution of innovative activities – business group and foreign ownership

Firm characteristic	Product	Process	Product & process	No innovation	Patent	TM
	%	%	%	%	%	%
Group	21.26	6.31	14.22	58.21	5.35	9.91
No group	13.81	5.29	8.59	72.31	0.88	2.04
Foreign	13.01	5.95	8.87	72.17	1.42	2.86
Domestic	23.15	5.39	9.32	62.14	1.32	2.86

Table 9 shows firms' responses to questions on the importance of different mechanisms to protect their innovations. Firms were asked in the CIS to evaluate the importance of the different mechanisms on a Likert scale between 0 and 3, where 0 means a firm does not use this type of protection mechanism whereas 3 means that it represents a 'very important' mechanism to the firm. Note that we interpret these variables interchangeably as self-reported use of a protection mechanism and the importance a firm attributes to the mechanism in protecting its innovations. For Table 9, we also group the different individual mechanisms into three broad categories: (a) formal IP which comprises patents, trademarks, registered designs, and copyright; (b) registered IP, i.e. patents, trademarks, and registered designs; and (c) informal IP which comprises secrecy, lead-time, complexity of design and confidentiality. In order to obtain these more aggregate indicators, we averaged its non-missing components and rounded to the nearest integer (between 0 and 3).

Table 9: Protection methods

Protection method	Not used (%)	Low (%)	Medium (%)	High (%)
Formal IP	78.01	11.39	6.92	3.68
Registered IP	80.70	9.85	5.99	3.47
Patent	83.76	5.93	4.43	5.87
Trademark	77.70	7.08	7.421	7.79
Registered design	82.53	6.83	5.48	5.16
Unregistered IP				
Copyright	79.12	7.40	6.11	7.37
Informal IP	66.17	14.94	13.13	5.76
Secrecy	67.83	11.18	11.5	9.49
Lead-time	66.70	9.68	12.64	10.99
Complexity	73.55	11.16	10.14	5.15
Confidentiality	66.58	9.32	11.56	12.54

The main message from Table 9 is that the overwhelming share of firms does not consider formal IP, and in particular patents, to be an important mechanism to protect inventions. The share of firms reporting no use of registered IP for all three CIS waves is 81%. Only 3.5% of firms regard registered IP as crucial. Within the registered IP category, trademarks appear to be considered the most important IP right, which is reflected in the considerably higher use of trademarks than patents by firms (Helmers *et al*., 2011). Unregistered IP in the form of copyright appears to be similarly popular as trademarks with about 20% of firms reporting some use of copyright protection.

Table 9 shows that informal IP mechanisms are regarded as more essential by firms than registered and unregistered IP. On average only 66% of firms across the three CIS waves report no use of any of the four informal mechanisms. Secrecy, lead-time and confidentially appear to be similarly important to firms. Complexity in design, which can be interpreted as a measure of the ease of re-engineering, appears to appeal less to firms as a way of protecting innovation. However, this may also be due to the fact that some firms cannot rely on this form of informal protection due to the nature of the good produced or service provided.

Table 10 shows more detailed information on firms' use of formal and informal IP by cross-tabulating the data with information on whether a firm reports to have only a product, only a process, or product and process innovations. The table reveals that both product and process innovators are observed to rely considerably more on formal IP. For example, whereas 90% of firms that do not report any innovation regard patent protection as unimportant, only slightly more than 60% of firms that have both a product and process innovation do not regard patents as important to protect their innovation.

Table 10: Formal IP methods

Protection method	Innovation type	Formal IP			
		Not used	**Low**	**Medium**	**High**
Formal IP	Product only	55.84	20.52	15.99	7.65
	Process only	72.75	15.14	8.66	3.45
	Product & process	45.53	25.25	18.86	10.36
	No innovation	86.46	7.746	3.66	2.13
Registered IP	Product only	60.46	18.42	13.93	7.19
	Process only	77.60	11.44	7.73	3.23
	Product & process	52.30	21.72	16.10	9.88
	No innovation	88.14	6.69	3.16	2.00
Design	Product only	68.50	11.26	10.07	10.18
	Process only	80.69	7.58	6.32	5.41
	Product & process	61.23	14.11	11.93	12.72
	No innovation	88.82	4.74	3.48	2.95
Trademark	Product only	59.79	10.93	13.76	15.51
	Process only	76.17	8.43	8.08	7.31
	Product & process	53.20	13.68	15.22	17.90
	No innovation	85.30	5.17	4.86	4.67
Patent	Product only	69.56	10.12	8.12	12.20
	Process only	81.61	6.821	5.20	6.36
	Product & process	62.02	12.21	9.75	16.02
	No innovation	90.19	4.03	2.81	2.96
Copyright	Product only	62.37	12.82	11.78	13.04
	Process only	74.73	10.16	7.39	7.72
	Product & process	51.94	15.30	13.24	19.52
	No innovation	87.07	4.86	3.74	4.32

Table 11 is the informal IP counterpart to Table 10. The differences in the importance attributed by firms to informal IP mechanisms differ even more by whether firms report to have a product and/or process innovation than in the case of formal IP shown in Table 10. For example, looking at secrecy as a mechanism to protect innovations, only 30% of product and process innovators report not to rely on it, whereas 79% of non- innovating firms do so.

Table 11: Informal IP methods

Protection method	Innovation type	Informal IP			
		Not used	**Low**	**Medium**	**High**
Informal IP	Product only	35.31	24.70	27.52	12.47
	Process only	47.59	25.23	19.82	7.36
	Product & process	20.75	22.73	35.79	20.73
	No innovation	78.71	11.52	7.22	2.55
Secrecy	Product only	44.89	17.43	20.40	17.29
	Process only	55.61	16.76	15.70	11.93
	Product & process	30.13	18.87	25.27	25.72
	No innovation	79.32	8.27	7.22	5.19
Lead-time	Product only	41.24	15.41	22.68	20.66
	Process only	53.44	13.67	18.42	14.47
	Product & process	25.78	14.26	27.88	32.08
	No innovation	79.31	7.45	7.76	5.47
Complexity	Product only	50.12	19.37	19.33	11.17
	Process only	63.93	16.10	14.43	5.54
	Product & process	35.70	22.21	26.01	16.09
	No innovation	84.96	7.37	5.47	2.19
Confidentiality	Product only	43.68	13.68	20.24	22.40
	Process only	55.77	13.05	15.07	16.11
	Product & process	30.08	13.48	21.81	34.63
	No innovation	77.77	7.49	7.90	6.84

Table 12 shows a cross-tabulation of firms' actual patenting activity and the CIS answers with regard to the importance of formal and informal IP protection mechanisms. As would be expected, the share of firms regarding formal IP as important is substantially larger for patenting than for non-patenting firms. About a quarter of patenting firms regard registered IP as crucial and nearly 60% of patenting firms regard patents as a crucial mechanism to protect innovations. Patenting firms are also seen to rely much more heavily on informal protection mechanisms than non-patenting firms. For example, almost 40% of patentees consider secrecy as crucial whereas only 9% of non-patenting firms do so. This illustrates that, in practice, firms are likely to consider a mix of different appropriability mechanisms. This in turn suggests that if firms actively manage their innovative activities, they also actively manage the protection and exploitation of innovations. Table 12 also shows that about 5% of firms that have not applied for a patent during the CIS reference period still regard patents as crucial mechanisms for protecting innovation. While the figure may simply reflect measurement error or delays in filing, it may also hint at a perceived importance of patents held by competitors.

Table 12: Protection methods & patenting decision

Protection method	Not used	Low	Medium	High
	Patent: yes			
	Formal IP			
Formal IP	17.78	23.28	36.25	22.7
Registered IP	18.84	21.34	34.25	25.57
Design	34.57	17.58	20.67	27.18
Trademark	28.77	17.07	24.53	29.64
CIS patent	15.98	9.42	15.15	59.45
Copyright	35.64	23.18	19.27	21.91
	Informal IP			
Informal IP	16.20	14.12	38.90	30.78
Secrecy	18.29	15.67	26.80	39.24
Lead-time	19.54	18.18	28.25	34.04
Complexity	20.83	25.72	29.95	23.50
Confidentiality	17.53	12.23	23.30	46.94
	Patent: no			
Protection method	**Not used**	**Low**	**Medium**	**High**
	Formal IP			
Formal IP	78.84	11.23	6.51	3.41
Registered IP	81.55	9.68	5.59	3.16
Design	83.26	6.66	5.24	4.82
Trademark	78.45	6.92	7.15	7.45
CIS patent	84.82	5.87	4.26	5.04
Copyright	79.78	7.16	5.9	7.14
	Informal IP			
Informal IP	66.85	14.96	12.78	5.41
Secrecy	68.59	11.11	11.26	9.03
Lead-time	67.42	9.54	12.4	10.64
Complexity	74.37	10.93	9.84	4.86
Confidentiality	67.33	9.28	11.38	12.01

Table 13 shows a breakdown of firms' patenting activities by firm size and the underlying innovation (product vs. process). Table 13 suggests that firms invent more product than process innovations independently of their size. It might be tempting to conclude from the data displayed in Table 13 that small firms are far less innovative than large firms because the share of product and process innovators among small firms is less than half the share of product and process innovators in the large firm size category. However, this rather reveals a major shortcoming of the way the CIS collects information on firms' innovative behaviour: firms are asked to respond either yes or no to the question of whether they have produced an innovation. This creates a size-bias, that is, larger firms are more likely to answer yes and, therefore, to be considered innovative. Table 13 also shows that the share of patenting firms differs dramatically across size categories. Whereas only 0.7% of small firms patent, 10% of large companies do so. Yet, one could argue that a similar size bias applies to the patenting and trademarking dummy variable, i.e. larger firms are more likely to have at least one patent or trademark. This size bias inherent in binary response variables in the present context, therefore, calls for caution in interpreting the statistics shown in Table 13.

Table 13: Innovation and patenting propensities across size categories

Size category	Product only (% yes)	Process only (% yes)	Product & process (% yes)	No innovation (% yes)	Patent (% yes)	TM (% yes)
Small	13.65	4.84	8.06	73.45	0.71	1.74
Medium	18.48	7.31	12.22	61.99	2.61	5.36
Large	20.55	11.08	21.42	46.95	10.01	16.98
Total	**14.54**	**5.39**	**9.18**	**70.89**	**1.35**	**2.86**

Table 14 explores how firms' perceptions of the importance of the different protection mechanisms differ across firm size categories. Larger firms report a considerably higher reliance on any type of appropriation mechanism, including both formal and informal IP. This suggests the intuitive conclusion that larger firms manage their innovations more actively and exploit the whole available range of IP protection mechanisms. In particular, given the managerial challenges involved in obtaining formal IP protection or relying on informal ways to protect a technology, such as maintaining an invention secret, large firms may be in an advantageous position relative to small firms.

Table 14: Protection methods by firm size

Protection method	Size category	Formal IP			
		Not used	**Low**	**Medium**	**High**
Formal IP	Small	80.97	10.19	5.84	3.00
	Medium	67.38	15.92	10.55	6.15
	Large	54.86	20.10	16.17	8.86
Registered IP	Small	83.61	8.71	4.95	2.72
	Medium	70.37	13.98	9.43	6.21
	Large	57.54	18.46	14.92	9.08
Design	Small	85.11	6.00	4.59	4.28
	Medium	74.19	9.38	8.18	8.23
	Large	62.29	13.58	12.93	11.19
Trademark	Small	80.81	6.28	6.39	6.50
	Medium	67.51	9.55	10.71	12.22
	Large	53.89	13.66	15.52	16.93
Patent	Small	86.64	5.08	3.67	4.60
	Medium	74.52	8.51	6.57	10.39
	Large	61.28	13.03	11.48	14.21
Copyright	Small	81.34	6.46	5.37	6.83
	Medium	72.43	10.12	8.18	9.26
	Large	60.10	15.96	12.86	11.08
Protection method	Size category	**Informal IP**			
		Not used	**Low**	**Medium**	**High**
Informal IP	Small	69.69	13.94	11.40	4.96
	Medium	53.10	18.94	19.44	8.51
	Large	39.88	21.41	26.37	12.34
Secrecy	Small	71.34	10.12	10.20	8.33
	Medium	56.28	14.91	15.42	13.40
	Large	40.94	18.42	22.6	18.04
Lead-time	Small	70.03	8.63	11.25	10.07
	Medium	55.47	13.01	17.35	14.17
	Large	42.15	17.85	22.61	17.39
Complexity	Small	76.76	9.74	8.94	4.54
	Medium	62.74	16.17	13.95	7.13
	Large	50.07	20.59	19.67	9.67
Confidentiality	Small	70.29	8.44	10.26	11.01
	Medium	54.18	12.36	15.75	17.71
	Large	38.90	15.55	21.88	23.67

Table 7 suggested large differences in innovative and IP activities across sectors. Tables 15 and 16, therefore, look at differences in the use of formal (Table 15) and informal (Table 16) IP across sectors. The self-reported reliance on formal and informal IP follows the patterns depicted in Table 7. The high-tech and R&D services sectors rely most on formal and registered IP. The share of firms reporting no use of registered IP is only 54% in the R&D services sector, but 85% in non-manufacturing industries. A similar pattern applies to patents: 45% of firms in R&D services report the use of patents whereas only 12% of non-manufacturing firms do so. Table 16 shows that these cross-industry differences are even larger with respect to informal IP. Around 62% of firms in the high-tech and R&D services sectors rely on secrecy, whereas only 28% of non-manufacturing firms do. Hence, the most innovative and IP active industries (Table 7) also report to rely most on any type of IP.

Table 15: Protection methods by sector – Formal IP

Protection method	Sector	**Formal IP**			
		Not used	**Low**	**Medium**	**High**
Formal IP	High-tech	56.99	16.48	17.18	9.34
	Medium-tech	56.57	18.56	15.81	9.052
	Other manufacturing	72.68	13.45	9.085	4.786
	Non manufacturing	81.81	10.01	5.35	2.82
	R&D services	46.48	27.83	17.30	8.38
Registered IP	High-tech	59.30	14.90	16.53	9.26
	Medium-tech	58.77	17.33	14.05	9.847
	Other manufacturing	75.27	11.8	8.224	4.703
	Non manufacturing	84.48	8.54	4.47	2.49
	R&D services	54.15	21.32	15.40	9.13
Patents	High-tech	60.51	9.67	11.24	18.57
	Medium-tech	60.35	10.35	11.42	17.88
	Other manufacturing	78.11	7.402	6.48	8.011
	Non manufacturing	87.94	5.15	3.20	3.69
	R&D services	55.63	6.26	7.36	30.74
Trademarks	High-tech	58.65	10.91	15.93	14.50
	Medium-tech	57.35	11.44	15.38	15.84
	Other manufacturing	73.07	8.225	9.246	9.459
	Non manufacturing	81.10	6.30	6.02	6.576
	R&D services	59.91	11.87	16.64	11.58
Design	High-tech	64.15	11.55	12.73	11.57
	Medium-tech	63.17	12.26	12.24	12.33
	Other manufacturing	77.04	8.228	7.596	7.137
	Non manufacturing	85.93	5.88	4.24	3.93
	R&D services	71.03	11.89	7.93	9.13
Copyright	High-tech	60.02	14.13	13.63	12.22
	Medium-tech	63.62	13.37	11.96	11.04
	Other manufacturing	75.69	8.555	7.645	8.106
	Non manufacturing	82.02	6.39	5.00	6.57
	R&D services	53.24	14.33	12.34	20.09

Table 16: Protection methods by sector – Informal IP

Protection method	Sector	Informal IP			
		Not used	**Low**	**Medium**	**High**
Informal IP	High-tech	34.06	16.75	31.84	17.35
	Medium-tech	39.53	18.66	27.37	14.44
	Other manufacturing	58.34	19.12	15.97	6.567
	Non manufacturing	71.22	13.53	10.82	4.42
	R&D services	33.01	21.53	24.37	21.08
Secrecy	High-tech	38.47	14.62	23.09	23.83
	Medium-tech	43.1	15.27	21.59	20.05
	Other manufacturing	62.39	14.22	13.09	10.31
	Non manufacturing	72.23	10.00	9.99	7.77
	R&D services	37.69	14.43	16.95	30.94
Confidentiality	High-tech	35.58	13.21	21.82	29.39
	Medium-tech	44.46	12.65	20.28	22.61
	Other manufacturing	63.58	11.23	13.69	11.49
	Non manufacturing	70.40	8.49	10.09	11.02
	R&D services	28.71	11.00	15.05	45.24
Lead-time	High-tech	33.97	15.92	26.69	23.41
	Medium-tech	36.06	15.33	24.47	24.14
	Other manufacturing	56.5	11.97	16.62	14.9
	Non manufacturing	72.64	8.443	10.34	8.58
	R&D services	43.96	15.34	19.03	21.67
Complexity	High-tech	38.05	17.98	26.73	17.24
	Medium-tech	41.96	20.37	24.91	12.77
	Other manufacturing	65.43	14.61	13.85	6.107
	Non manufacturing	79.08	9.34	7.715	3.86
	R&D services	52.72	19.14	12.71	15.43

Table 17 combines information on the size of the inventive step (which can also be interpreted as a measure of the 'quality' of an innovation) with information on a firm's perception of the importance of formal and informal IP as well as on its actual patenting and trademarking activity. Registered IP in the form of patents, trademarks and registered designs is used more by firms that produce an innovation that is 'new to the market' than by those with only an innovation that is new to the firm. This is reasonable given the novelty test applied in the patent examination process.[13] Consistent with this, firms report to attribute most importance to patents if their innovation is 'new to the market'. This pattern is also found in the distribution of actual patent applications. The share of patenting firms with innovations that are 'new to the market' is more than twice as large as that of patenting firms with an innovation that is only 'new to the firm'. The distributions for informal protection mechanisms including secrecy reveal once more that firms rely on these methods more than on

[13]The novelty criterion stipulates that the invention must not yet be in the public domain anywhere in the world before the priority date of the corresponding patent. This means that in practice, at the priority date, there must not exist any other single document that contains all the features of all claims contained in the patent application.

formal IP. Firms that have a product innovation that is 'new to the market' report to use 'alternative' mechanisms most.

Table 17 shows also information on firms' innovative performance measured as the share in sales due to innovations that are either 'new to the firm' or 'new to the market'. The most striking feature of the sales data is the large difference between firms that report to rely on any form of formal or informal IP provided that they have an innovation that is 'new to the market', whereas there is no such large gap in innovative performance for firms with innovations that are only 'new to the firm'. This provides some preliminary evidence that firms that actively employ IP protection mechanisms are able to capitalise more on their innovations than firms that do not use any active IP management. This argument, however, also suggests that these firms may be generally better managed and hence their better innovative performance is likely to be due to a combination of factors rather than only due to IP protection of some form.

Table 17: Inventive step and protection methods

Protection method		**Size of inventive step**			
		New to the firm		**New to the market**	
		%	**Average share in turnover**	**%**	**Average share in turnover**
Formal IP	Not used	55.87	16.47	39.53	8.19
	Used	44.13	15.71	60.47	13.96
Registered IP	Not used	60.64	16.60	46.08	8.85
	Used	39.36	15.44	53.92	13.84
Design	Not used	67.36	16.24	57.91	9.78
	Used	32.64	15.49	42.09	13.43
Trademark	Not used	61.19	16.30	47.25	9.10
	Used	38.81	15.58	52.75	13.61
CIS Patent*	Not used	70.33	16.43	56.05	9.54
	Used	29.67	15.14	43.95	14.04
Copyright	Not used	62.17	16.20	47.68	8.60
	Used	37.83	15.71	52.32	14.38
UK/EPO Patent**	No	97.3	16.22	93.71	10.73
	Yes	2.70	13.33	6.28	18.13
Trademark	No	94.89	16.11	91.57	10.83
	Yes	5.11	15.85	8.42	14.12
Informal IP	Not used	31.33	15.30	17.81	6.46
	Used	68.67	16.42	82.19	12.83
Confidentiality	Not used	41.34	15.14	27.78	7.63
	Used	58.66	16.54	62.22	13.24
Secrecy	Not used	42.11	15.60	27.78	7.38
	Used	57.89	16.21	62.22	13.34
Complexity	Not used	48.29	15.59	31.42	7.70
	Used	51.71	16.35	68.58	13.67
Lead-time	Not used	39.15	15.45	22.53	7.02
	Used	60.85	16.30	77.47	13.24

Note: The variables reporting firms' perceptions of the importance of appropriability mechanisms were reduced to binary variables indicating either 'no use' or 'use' which includes the three categories: low, medium, and high importance.
* Self-reported importance attributed to patents as protection mechanism
** Dummy variable indicating whether firm holds patent

Tables 18 and 19 provide additional descriptive evidence on the association of a firm's innovative activity and its share in sales due to an innovation. For ease of illustration, in Tables 18 and 19, we discretise firms' sales distribution into four size bands (0%; more than 0% and less than 10%; between 10% and less than 25%; and 25% and above).

When looking at innovations that are 'new to the firm' in Table 18, we do not see any strong discernable pattern in the distribution of firms across turnover bands. Firms appear to be distributed similarly across turnover size bands, independently of how highly they rank formal or informal IP. This suggests that there is little correlation between a firm's innovative performance in terms of turnover due to innovative products that are 'new to the firm' and the importance the firm attaches to the different protection mechanisms. However, the data look different for innovations that are 'new to the market' in Table 19. In particular, firms that attach high importance to patents and/or secrecy appear to perform better. For example, only 10% of firms that indicate that they do not use patents are in the ≥25% turnover category, whereas more than 20% of firms that regard patents as crucial are. The difference is even more pronounced with regard to the use of informal protection mechanisms as only 10% of firms reporting not to employ informal mechanisms are in the ≥25% turnover category, whereas 31% of firms are that report these mechanisms to be crucial for their business. Overall, this suggests that firms that regard patents and/or secrecy as important, and that have a product innovation that is 'new to the market', outperform firms that have an innovation that is 'new to the market' but that do not use patents and/or secrecy. However, as already pointed out above, the evidence presented here provides only a partial view of the relation between IP use and innovative performance and does not account for other potentially important factors in determining a firm's innovative performance. This will be the focus of the following two sections.

Table 18: Turnover due to product innovation and protection methods: 'new to the firm'

Protection method	% Turnover due to product innovation 'new to the firm'				Total
	0%	**<10%**	**≥10%-25%<**	**≥25%**	
Formal IP					
Not used	53.54	50.72	48.97	52.31	51.22
Low	22.14	22.16	23.39	22.72	22.67
Medium	16.63	18.84	17.87	16.59	17.49
High	7.69	8.27	9.76	8.37	8.62
Patents					
Not used	67.63	64.76	64.29	68.81	66.20
Low	9.74	11.44	11.92	10.28	10.91
Medium	8.08	9.14	10.12	8.19	8.98
High	14.54	14.65	13.66	12.72	13.91
Informal IP					
Not used	33.17	28.73	25.57	27.27	28.56
Low	21.54	26.81	24.34	24.36	24.14
Medium	29.40	30.92	34.08	31.4	31.64
High	15.89	13.54	16.02	16.97	15.66
Secrecy					
Not used	42.38	38.40	35.24	36.98	38.13
Low	16.45	19.12	19.82	19.37	18.70
Medium	20.82	21.88	23.87	22.75	22.42
High	20.35	20.60	21.06	20.89	20.74

Table 19: Turnover due to product innovation and protection methods: 'new to the market'

Protection method	% Turnover due to product innovation 'new to the market'				Total
	0%	**<10%**	**≥10%-25%<**	**≥25%**	
Formal IP					
Not used	65.79	45.28	48.48	46.70	55.99
Low	17.07	23.86	21.31	23.56	20.02
Medium	11.13	19.81	18.43	20.70	15.48
High	6.00	11.05	11.77	9.03	8.51
Patents					
Not used	74.65	53.28	57.94	59.15	65.25
Low	8.72	15.96	13.34	10.19	11.17
Medium	6.80	10.25	12.20	10.51	9.06
High	9.80	20.51	16.52	20.15	14.51
Informal IP					
Not used	37.36	20.54	18.81	18.04	27.90
Low	26.15	24.39	21.41	18.06	23.74
Medium	26.78	37.23	38.62	32.44	31.86
High	9.71	17.84	21.15	31.45	16.50
Secrecy					
Not used	46.51	32.41	27.38	26.44	37.23
Low	18.60	18.39	19.13	14.76	18.15
Medium	19.36	24.36	27.85	26.33	22.99
High	15.53	24.84	25.65	32.48	21.62

5. Empirical Approach

In our literature review (Hall *et al*., 2011), we summarised the existing theoretical and empirical evidence on a firm's choice between patenting and informal protection mechanisms. We build on this review in formulating our empirical approach. Previous research (see Section2) has used a firm's perception of the importance of formal and informal IP as the dependent variable. Thanks to the integrated dataset described in Section 3, we can assess directly the determinants of a firm's observed decision to patent. Moreover, our data allow us to condition a firm´s choice on the firm having an innovation and the firm's self-reported reliance on informal protection mechanisms, in particular secrecy. By restricting the sample accordingly, this enables us to interpret a firm's decision not to patent an innovation as a decision in favour of secrecy and other informal methods of protection. Hence, the availability of data on a firm's innovative activities, its self-reported reliance on different protection mechanisms and observed patenting behaviour allow us to investigate the variables that influence a firm´s decision to patent or maintain an innovation secret.

This implies that in the regression analysis presented in Section 6 we use two samples that are subsamples of the data used in Section 4. First, we limit the sample to firms that report a product and/or process innovation during the CIS reference period in order to ensure that in principle all firms face the decision of how to protect their innovation. However, when using this dataset, we are unable to tell non-patenting firms apart that choose to protect their innovation by informal IP or simply choose to do nothing. In order to distinguish these two types of responses, we also restrict the sample further to firms that are either observed to patent or report some reliance on informal IP, in particular secrecy.[14]

Our main equation of interest is, therefore:

$$p_{ijc} = \alpha + \beta fip_{ijc} + \theta iip_{ijc} + \varphi prod_{ijc} + \vartheta rd_{ijc} + \gamma X_{ijc} + \delta Z_{jc} + \delta_c + \mu_j + \varepsilon_{ijc} \qquad (1)$$

p_{ijc} denotes firm *i*'s patenting decision (firm *i* is in sector *j* and CIS wave *c*). This means that we reduce a firm´s decision to a binary choice, either the firm decides to patent or not.[15] fip_{ijc} represents a firm's perception of the importance of protection mechanisms in the form of formal intellectual property. iip_{ijc} denotes the importance a firm attributes to informal protection mechanisms including secrecy. In fact, most of our empirical specifications will capture formal IP only in the form of patents, and informal mechanisms only in form of secrecy. These variables vary between 0 and 3 and indicate a firm´s response to the question about the importance of a method to protect innovations to the firm. A value of zero means that the firm attaches no importance to the mechanism, whereas 3 means it represents an essential mechanism to protect innovations. Since these are subjective measures of importance, which may be difficult to compare across firms, Arundel (2001) suggests using the difference between the importance attributed to patents and secrecy. While levels may be difficult to compare, differences should be internally consistent. For example consider a firm that attributes a value of 1 to patents and 2 to secrecy while another attributes 2 to patents and 3 to secrecy. These differences in levels within protection mechanisms may not necessarily be comparable across firms, while the difference for both firms should be, i.e. both value secrecy by 1 unit more than patents. Hence, as a robustness check of our analysis, we also replace fip_{ijc} and iip_{ijc} by their difference.[16] There is reason to be concerned about potential endogeneity of the fip_{ijc} and iip_{ijc} variables. However, in this report, we focus on pointing out robust associations in the data and relegate potential endogeneity issues to the last part of this

[14] The Appendix also contains results of a bivariate probit that estimates the joint probability of a firm relying on patenting and secrecy. For the bivariate probit, the dependent variables are the patent dummy as well as a dummy indicating whether a given firm reports some reliance on secrecy as a protection mechanism.

[15] We are aware that by collapsing the number of a firm´s patent applications to a binary variable, we lose potential information contained in the variation in the number of patents a firm applies for. However, given our main research objective, that is, to investigate a firm´s choice between patenting and secrecy, we are primarily interested in whether a firm applies for a patent at all, and less in its patenting intensity.

[16] The example also illustrates that using the difference potentially leads to loss in variation across firms. This is one reason why we use both variables separately in our preferred specification. Another reason is that including separate variables allows us to test the effect each variable has on its own and whether there exist differences in the effect between the two variables.

project. Equation (1) also includes dummy variables c for each CIS wave to account for time-varying effects.

$prod_{ijc}$ denotes a dummy variable indicating whether a firm has a product innovation or alternatively whether the product innovation is 'new to the market'. This variable is included to capture the possibility that product innovations (that are 'new to the market') are more likely to represent patentable subject matter in the UK than process innovations (Cohen *et al*., 2001; Farooqui, 2009). In addition, the variable that indicates whether a product innovation is 'new to the market' may also capture the costs associated with disclosing the invention to the public. If firms consider inventions characterised by a larger inventive step to be more valuable, then disclosing the information through a patent application may be less desirable to the firm and hence a firm may be more likely to opt for secrecy (Anton and Yao, 2004). Hence, *a priori* it is difficult to predict the sign of the coefficient associated with $prod_{ijc}$.

rd_{ijc} denotes a dummy variable that indicates whether the firm conducts some form of R&D. While it would be expected that all firms that have a product or process innovation (to which the regression sample is restricted) conduct some form of R&D, there are nevertheless innovators in the sample that report no R&D activity during the reference period. To account for these firms, the R&D dummy variable is included in the specification.

X_{ijc} is a vector of firm-level characteristics including age, size, whether the firm belong to a business group, exporting status etc. Z_{jc} is a vector of industry-level variables (at SIC 3-digit level), including a measure of market concentration and a measure of how R&D intensive industries are. μ_j denotes industry-level fixed effects. Due to the binary dependent variable, Equation (1) is estimated as a logit model with standard errors robust to heteroskedasticity and clustered on the firm for estimation.

In a second step, we analyse the effect of a firm's observed decision to patent on its (innovative) performance. As performance measures, we use (a) the share of a firm's turnover that is due to innovations, where we use separate variables for innovations that are 'new to the firm' and 'new to the market'. This allows us to distinguish between the effect of patenting on a firm's sales based on imitation ('new to the firm') and innovation ('new to the market'). In addition, we also use (b) firm growth measured by employment as a performance measure.[17] We refer to measure (a) as innovative performance to distinguish it from performance measure (b). The model specification is thus:

$$performance_{ijc} - \alpha + \beta p_{ijc} + \gamma X_{ijc} + \delta Z_{jc} + \delta_c + \mu_j + \varepsilon_{ijc} \qquad (2)$$

[17] We also investigated labour productivity as performance measures. However, labour productivity is only available for firms that are included in the ARD2. This means that the sample is considerably smaller and we, therefore, prefer to rely on the CIS-based turnover performance measure and employment growth computed using the BSD.

In Equation (2), the main object of interest is the variable p_{ijc} which indicates whether a firm has applied for a patent during the reference period. X_{ijc} is a vector of firm-level characteristics and Z_{jc} a vector of industry-level variables.

Note that for the regression analysis, we restrict the data to sectors that have been sampled in all three CIS waves, i.e. we exclude 'sale, maintenance & repair of motor vehicles' (SIC 50), retail trade (SIC 52), hotels & restaurants (SIC 55), motion picture and video activities (SIC 921) and radio and television activities (SIC 922).

6. Results

Before discussing the regression results, we briefly discuss the characteristics of the reduced data sets employed in the regression analysis (i.e. (1) limited to product and process innovators and sectors sampled in all three CIS waves and (2) applying the same restrictions as in (1) and limited to firms that use formal and/or informal IP) and provide some descriptive statistics of the variables used in the analysis.

Table 20 shows the number of observations for each CIS wave for the restricted sample used in the regression analysis. Keeping only innovators (product and process) and sectors sampled in all three CIS waves (Sample 1) reduces the sample to about a third of the original sample size (see Table 1). CIS 4 still provides the largest sample accounting for nearly 45% of observations, followed by CIS 5 with 34%. Limiting the sample further to firms that patent and/or report some use of informal IP in the form of secrecy reduces the number of observations to 7,388, that is, 24% of the original sample. The distribution of Sample 2 across the three CIS waves is nevertheless very similar to Sample 1.

Table 20: Regression sample size by year

	CIS 3	CIS 4	CIS 5	Total
Sample 1				
Number of observations	2,392	5,132	3,929	11,453
%	20.89	44.81	34.31	100
Sample 2				
Number of observations	1,330	3,447	2,611	7,388
%	18.00	46.66	35.34	100

Table 21 shows the panel structure of the reduced samples used in the regression analysis. In Sample 1, there are only 113 firms which have been sampled in all three CIS waves. This number reduces to 79 for Sample 2. As for the full sample, the overlap is greatest for CIS 3 and CIS 4 with 1,183 and 734 firms in Samples 1 and 2 respectively. Yet, about 85% of firms are included in only a single CIS in both samples, which significantly limits our ability to exploit inter-temporal variation in our analysis to account for unobserved individual heterogeneity and explore potential dynamics in a firm's patenting decision.

Table 21: Panel structure of regression sample

<table>
<tr><th>Number of firms</th><th>%</th><th>CIS 3</th><th>CIS 4</th><th>CIS 5</th></tr>
<tr><td colspan="5">Sample 1 (innovating firms)</td></tr>
<tr><td>113</td><td>1.15</td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td></tr>
<tr><td>171</td><td>1.75</td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td><td></td></tr>
<tr><td>1,183</td><td>12.08</td><td></td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td></tr>
<tr><td>82</td><td>0.84</td><td style="background:#c0c0c0"></td><td></td><td style="background:#c0c0c0"></td></tr>
<tr><td>2,026</td><td>20.69</td><td style="background:#c0c0c0"></td><td></td><td></td></tr>
<tr><td>3,665</td><td>37.43</td><td></td><td style="background:#c0c0c0"></td><td></td></tr>
<tr><td>2,551</td><td>26.05</td><td></td><td></td><td style="background:#c0c0c0"></td></tr>
<tr><td>9,791</td><td>100</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Sample 2 (innovating firms that use some form of IP)</td></tr>
<tr><td>79</td><td>1.25</td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td></tr>
<tr><td>115</td><td>1.82</td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td><td></td></tr>
<tr><td>734</td><td>11.60</td><td></td><td style="background:#c0c0c0"></td><td style="background:#c0c0c0"></td></tr>
<tr><td>56</td><td>0.89</td><td style="background:#c0c0c0"></td><td></td><td style="background:#c0c0c0"></td></tr>
<tr><td>1,080</td><td>17.08</td><td style="background:#c0c0c0"></td><td></td><td></td></tr>
<tr><td>2,519</td><td>39.83</td><td></td><td style="background:#c0c0c0"></td><td></td></tr>
<tr><td>1,742</td><td>27.54</td><td></td><td></td><td style="background:#c0c0c0"></td></tr>
<tr><td>6,325</td><td>100</td><td></td><td></td><td></td></tr>
</table>

Note: Grey-shaded rectangles indicate data are available.

Table 22 shows some basic descriptive statistics for the variables employed in our regression analysis. We use unweighted data for our regressions and the descriptive statistics shown in Table 22 are, therefore, also unweighted. The main variable of interest is a firm's observed patenting decision 'Patent (0/1)'. Its mean of 0.06 in Sample 1 indicates that only about 6% of firms patent during any of the CIS references periods. This share increases to 9.5% in Sample 2. Both shares are much larger than the overall share of patenting firms in the full sample (see Table 7). The principal explanatory variables of interest are 'Formal IP'/ 'Registered IP' and 'Informal IP'. In addition, we focus specifically on 'Patents' and 'Secrecy', which are the 0-3 scores attached by firms to the importance of these two mechanisms to protecting innovations. The mean of 1.43 attached to informal IP in Sample 1 is considerably higher than the 0.843 attached to registered IP, reflecting our findings in Section 4 that firms appear to value informal IP on average more than formal/ registered IP as a means to protect innovations. The standard deviations are similar in magnitude. Table 22 also provides information on a large number of firm characteristics and data on responses that firms have given in the CIS to questions related to their innovative activities. We explore the associations of these variables with a firm's observed decision to patent in various variations of the basic model specification, as spelled out in Equation (1). Appendix A2 shows a correlation matrix of the different measures of formal and informal IP.

Table 22: Descriptive statistics

Variable	Sample 1			Sample 2		
	Mean	St. dev.	Obs.	Mean	St. dev.	Obs.
Patent (0/1)	0.062	0.241	11,453	0.095	0.294	7,388
Formal IP	0.913	1.038	11,453	1.280	1.049	7,388
Registered IP	0.843	1.043	11,453	1.192	1.079	7,388
Design	0.781	1.098	11,036	1.086	1.161	7,325
Trademark	0.979	1.184	11,061	1.321	1.204	7,338
Patent	0.830	1.164	11,058	1.171	1.232	7,341
Copyright	0.884	1.132	11,023	1.217	1.167	7,323
Informal IP	1.430	1.042	11,453	2.004	0.738	7,388
Confidentiality	1.488	1.226	11,092	2.002	1.028	7,359
Secrecy	1.359	1.165	11,071	2.037	0.808	7,388
Complexity	1.111	1.079	11,057	1.545	0.981	7,351
Lead-time	1.487	1.178	11,084	1.939	0.979	7,364
Patents -- Secrecy	-0.522	1.195	11,107	-0.857	1.286	7,388
Any R&D (0/1)	0.914	0.279	11,453	0.953	0.209	7,388
Product innovator (0/1)	0.812	0.390	11,452	0.860	0.346	7,387
Trademark (0/1)	0.088	0.284	11,453	0.117	0.322	7,388
Employment	0.383	1.647	11,453	0.475	1.901	7,388
Ln Employment	0.192	0.374	11,453	0.231	0.413	7,388
Age	16.825	9.657	11,453	16.849	9.633	7,388
Ln Age	2.665	0.754	11,453	2.669	0.749	7,388
Business group member (0/1)	0.235	0.424	11,453	0.275	0.446	7,388
Share employees science & engineering *100	11.429	25.472	10,586	13.974	26.937	6,934
Any form of research cooperation (0/1)	0.314	0.464	11,357	0.374	0.483	7,381
High-tech (0/1)	0.060	0.239	11,453	0.074	0.262	7,388
Constraint to innovation: market dominated by established businesses	1.166	0.974	8,990	1.323	0.931	6,048
Export status (0/1)	0.329	0.469	11,453	0.378	0.485	7,388
Management practice	0.428	0.646	11,289	0.473	0.652	7,363
Direct cost of innovation (0=no problem, 3=high)	1.525	1.069	11,302	1.701	0.977	7,366
Uncertainty (0=no problem, 3=high)	1.313	0.882	11,291	1.486	0.815	7,365
Financial constraints (0=no problem, 3=high)	1.333	1.017	11,298	1.469	0.969	7,365
% turnover from innovation new to market	8.583	18.047	9,261	9.950	19.189	6,273
% turnover from innovation new to firm	12.870	20.206	9,472	13.178	19.683	6,374
Market concentration Herfindahl index (SIC 3-digit level)	0.020	0.053	11,453	0.021	.049	7,388
R&D intensity in % (SIC 3-digit level)	3.575	6.763	11,368	3.710	5.755	7,341

Notes: (0/1) indicates dummy variable;

6.1 The decision between formal and informal IP

Table 23 shows the first set of results for the most restricted specification of the model specified in Equation (1). For these regressions, we use the constructed variables that represent a firm's use of formal and informal IP protection methods. The marginal effects shown indicate a positive and statistically significant association between both informal methods and formal (registered) IP and a firm's propensity to patent. However, when we include sector-level fixed effects,[18] the coefficients associated with informal IP are no longer statistically significant or only marginally significant. In contrast, the statistical significance of the formal IP variable is unaffected by the inclusion of sector-level fixed effects. Because the average patent propensity for this sample is 6.2%, the marginal effect of the importance of registered IP is large, adding about 2% to this number for a change from low to medium or medium to high.

The other variables included in the model specification indicate that product innovations are more likely to be patented than process innovations and that larger firms (measured as employment) are more likely to patent, as are older companies and firms that report some form of R&D during the reference period. The coefficient associated with firm size, measured as employment, can also be interpreted as a measure for the effect of direct and indirect financial costs associated with patenting. While the fees associated with patenting are the same for all firms in absolute terms, they will weigh heavier on smaller firms. This means that the effect of financial costs can be captured by including our measure of firm size. In Columns (3) and (4) we use a variable indicating whether a product innovation is 'new to the market' instead of the simple product innovation dummy variable. The results suggest that firms with product innovations that are novel are more likely to patent. Moreover, when we include both the product innovation dummy and the 'new to the market' indicator, only the novelty measure is statistically significant, suggesting that this provides incentives for firms to seek formal IP protection in form of a patent.

Table 23: Logit regression results (marginal effects) – part 1

Patent (0/1)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Informal IP	.005*** (.001)	.003* (.001)	.003** (.002)	.002 (.002)	.003** (.002)	.002 (.001)
Registered IP	.024*** (.001)	.020*** (.002)	.023*** (.001)	.019*** (.002)	.023*** (.002)	.019*** (.001)
Inventive step ('new to the market') (0/1)			.018*** (.003)	.016*** (.003)	.018*** (.003)	.016*** (.003)
Product innovator	.017*** (.003)	.016*** (.003)			.012 (.009)	.017** (.008)
Ln Employment	.029*** (.003)	.035*** (.003)	.027*** (.003)	.033*** (.003)	.027*** (.003)	.033*** (.003)
Ln Age	.007*** (.002)	.004** (.002)	.007*** (.002)	.004** (.002)	.007*** (.002)	.004** (.002)
Any R&D (0/1)	.023*** (.003)	.018*** (.003)	.034*** (.008)	.017*** (.003)	.022*** (.003)	.017*** (.004)
High-tech (0/1)	.036*** (.008)		.034*** (.008)		.034*** (.008)	
% correctly predicted	93.5	84.5	93.5	84.6	93.4	84.6
% correctly predicted p=1	6.1	11.1	6.7	11.7	6.5	11.7
% correctly predicted p=0	99.5	89.5	99.4	89.6	99.4	89.6
CIS Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes		Yes
# Observations	10,641	9,677	10,642	9,678	10,641	9,677

[18] The number of observations drops slightly when including industry-level fixed effects due to the absence of variation in the dependent variable in few sectors.

Note: Standard errors clustered by firm

In Table 24, we show the results from using the individual measures for formal and informal IP. The specifications shown in columns (1) and (2) of Table 24 include all eight measures for formal and informal IP (and the same set of controls as in Table 23). The results suggest that only a firm's self-reported use of patents and copyright are statistically significant. While the importance a firm attributes to patents as a means to protect innovations is strongly positively associated with a firm's observed patenting propensity, its use of copyright is negatively correlated although the magnitude of the effect is economically negligible. Columns (3) and (4) show results when using only patents as a measure of a firm's use of formal IP and the four measures of informal IP. Columns (5) and (6) reduce the set of variables to only patents and secrecy. The results shown in these four columns are consistently suggesting that only the importance attributed to patents is statistically significantly affecting a firm's patenting propensity.

Table 24: Logit regression results (marginal effects) – part 2

Patent (0/1)	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Design	.000 (.001)	.000 (.001)				
Trademark	-.002** (.001)	-.002 (.001)				
Patent	.024*** (.001)	.021*** (.001)	.022*** (.001)	.019*** (.001)	.022*** (.001)	.019*** (.001)
Confidentiality	.000 (.001)	-.001 (.001)	-.001 (.001)	-.001 (.001)		
Copyright	-.003*** (.001)	-.002** (.001)				
Secrecy	.001 (.001)	.001 (.001)	.001 (.001)	.0003 (.001)	.0001 (.001)	-.0001 (.001)
Complexity	.002 (.001)	.001 (.001)	.001 (.001)	.001 (.001)		
Lead-time	-.001 (.001)	.000 (.001)	-.001 (.001)	-.0005 (.001)		
Inventive step ('new to the market') (0/1)	.011*** (.003)	.011*** (.002)	.011*** (.002)	.011*** (.002)	.011*** (.002)	.011*** (.002)
Ln Employment	.023*** (.003)	.028*** (.003)	.023*** (.003)	.028 *** (.003)	.023*** (.002)	.028*** (.003)
Ln Age	.006*** (.002)	.004*** (.001)	.005*** (.001)	.004** (.002)	. 005*** (.001)	.004** (.001)
Any R&D (0/1)	.016*** (.002)	.014*** (.003)	.016*** (.002)	.015*** (.003)	.016*** (.002)	.014*** (.003)
High-tech (0/1)	.017*** (.005)		.019*** (.005)		.020*** (.005)	
% correctly predicted	92.8	83.9	93.1	84.2	93.4	84.5
% correctly predicted p=1	8.7	12.4	8.1	12.6	7.7	11.8
% correctly predicted p=0	98.6	88.8	98.9	89.1	99.3	89.4
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes		Yes
# Observations	10,567	9,606	10,607	9, 644	10,642	9,678

Note: Standard errors clustered by firm

Table 25 shows a richer specification of the basic model shown in Equation (1). The specifications shown in Table 25 contain also an indicator variable for whether the firm has registered a trademark (UK and/or OHIM) during the CIS reference period. This variable captures several potentially important effects. If a firm holds a trademark, this may suggest that the firm is familiar with the IP system and that it benefits from better knowledge and IP management. In addition, the firm may be able to spread the fixed costs associated with using the IP system over the different forms of IP it uses. In addition, we added an indicator variable of whether the firm is part of a business group. There is empirical evidence that suggests that firms that are part of business groups are more innovative and more likely to patent than stand-alone companies (Belenzon and Berkovitz, 2010). Our descriptive evidence in Section 4 also pointed into this direction. Hence, this variable captures any such business-group effects. We also include a variable from the CIS that indicates the share of a firm's employees that possess a science and/or engineering degree, which measures unobserved worker quality and ability to generate patentable subject matter. The specification shown in Columns (5) - (8) also includes dummy variables indicating whether a firm is an exporter and whether it maintains any form of research cooperation. Furthermore, we include several measures of potential constraints to innovating and patenting, including financial costs and market uncertainty. We also add industry-level (SIC 3-digit) variables to the specifications in Columns (5)-(8): a market concentration measure (Herfindahl index) constructed based on firms' employment data and R&D intensity measured as the ratio of intramural R&D spending and employment.[19] These variables capture variation across sectors in terms of the competitive environment that firms face, as well as the research intensity that governs different sectors. In columns (5)- (8), we add a variable from CIS that indicates whether firms consider that the market in which they operate is dominated by established firms and whether this represents a barrier to innovation. We interpret this variable as another measure of the effect of competition (from incumbents) on a firm's patenting choice.

The results shown in Table 25 are consistent with the results presented in Table 24 with regard to the importance of formal and informal IP in the form of patents and secrecy; the importance a firm attaches to secrecy as a method to protect innovations does not significantly affect a firm's observed patenting decision. In contrast, firms that consider patenting as important are also more likely to actually apply for a patent. These results are robust to changes in the specification across columns and the inclusion of sector fixed effects. The dummy variables indicating innovators with product innovations that are 'new to the market', trademarking firms and whether firms conduct some form of R&D have the expected positive signs and are statistically significant. Similar to Brouwer and Kleinknecht (1999), the results in Table 25 suggest that firms involved in some form of research collaboration are more likely to patent. Also, being part of a business group, as well as having a higher share of employees with a science/ engineering background, is positively associated with a firm's decision to patent. The measure of market concentration is statistically significantly different from zero in columns (6) and (8) where its negative sign indicates a negative correlation between concentration and a firm's patenting propensity. R&D intensity is only statistically significant when no sector-level fixed effects are used which suggests that it captures some of the sector-specific unobservables relevant for a firm's ability to patent. Moreover, Table 25 also shows results for the sample that is limited to firms that patent and/or rely on secrecy (columns (3) and (4) as well as (7)

[19] Note that the concentration measure was constructed using the entire UK census of firms and not only the sample used in the analysis.

and (8)). These columns inform more directly about the determinants of a firm's decision between patenting and maintaining an innovation secret. All of the coefficients obtained using this restricted sample (Sample 2) have the same sign as when using the unrestricted sample (Sample 1); only the magnitude of the marginal effects increases considerably when we employ Sample 2.

Table 25: Logit regression results (marginal effects) – part 3

	Sample 1		Sample 2		Sample 1		Sample 2	
Patent (0/1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Patents	.018*** (.001)	.015*** (.001)			.016*** (.001)	.014*** (.001)		
Secrecy	-.0008 (.0009)	-.0009 (.0009)			-.0005 (.0009)	-.0005 (.0009)		
Inventive step ('new to the market') (0/1)	.007*** (.002)	.007*** (.002)	.037*** (.006)	.028*** (.005)	.006*** (.002)	.006*** (.002)	.032*** (.007)	.026*** (.006)
Any R&D (0/1)	.013*** (.002)	.010*** (.002)	.038*** (.009)	.026*** (.009)	.012*** (.002)	.009*** (.003)	.039*** (.010)	.026** (.011)
Trademark (0/1)	.052*** (.007)	.064*** (.008)	.159*** (.017)	.169*** (.018)	.046*** (.007)	.055*** (.008)	.155*** (.018)	.157*** (.019)
Ln Employment	.010*** (.002)	.013*** (.002)	.024*** (.006)	.036*** (.007)	.008*** (.002)	.011*** (.002)	.018*** (.006)	.032*** (.006)
Business group member (0/1)	.017*** (.003)	.017*** (.003)	.054*** (.009)	.045*** (.008)	.015*** (.003)	.016*** (.003)	.049*** (.009)	.044*** (.008)
Ln Age	.003** (.001)	.002 (.002)	.014*** (.005)	.003 (.004)	.002 (.001)	.001 (.001)	.008* (.004)	.0001 (.004)
Share employees science & engineering	.0001*** (.0000)	.0001*** (.0000)	.0006*** (.0001)	.0006*** (.0001)	.0001*** (.0000)	.0001*** (.0000)	.0004*** (.0001)	.0005*** (.0001)
Foreign owned (0/1)					.001 (.001)	-.0004 (.001)	.013** (.006)	.001 (.005)
Any form of cooperation (0/1)					.007*** (.002)	.006*** (.002)	.026*** (.006)	.017*** (.005)
Constraint to innovation: market dominated by established businesses					-.001 (.001)	-.001 (.001)	-.006 (.003)	-.003 (.003)
Constraint to innovation: direct cost					-.0004 (.001)	-.0005 (.001)	-.001 (.003)	-.002 (.003)
Constraint: financing					-.002** (.001)	-.002** (.001)	-.004 (.003)	-.005* (.003)
Constraint: uncertainty					.002* (.001)	.002 (.001)	.008* (.004)	.005 (.003)
Market concentration Herfindahl index (SIC 3-digit level)					-.045 (.034)	-.093* (.056)	-.205* (.105)	-.334* (.176)
R&D intensity (SIC 3-digit level)					.0004* (.0002)	-.0003 (.0003)	.002*** (.0007)	-.0001 (.0008)
High-tech (0/1)	.020*** (.005)		.085*** (.017)		.018*** (.005)		.067*** (.017)	
% correctly predicted	87.9	80.2	85.4	79.2	73.4	66.8	73.5	68.2
% correctly predicted p=1	23.1	30.7	15.1	25.0	40.7	43.8	33.1	41.3
% correctly predicted p=0	92.3	83.6	92.9	85.0	75.6	68.4	77.8	71.1
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes		Yes		Yes
# Observations	9,955	9,085	6,662	6,193	8,145	7,418	5,550	5,144

Note: standard errors clustered by firm

Table 26 shows further results when including two more variables that might be of particular interest: whether the firm is an exporter and whether the firm reports to have introduced ‘advanced management techniques’, such as knowledge management systems. The exporter variable comes from the ARD2 and is derived from information on firms’ exporting activity in services. It is =1 if a firm is observed to have exported during the CIS reference period. This variable, which can be regarded as more reliable than the CIS-based information, is positive and statistically significant indicating that there is a positive association between exporting and patenting. As to the management variable, the results suggest that the introduction of such management practices appears to lower a firm’s patenting propensity. The latter may be explained by a firm’s improved ability to maintain innovations secret, which may thus lower a firm’s desire to protect innovations by registered IP.

Table 26: Logit regression results (marginal effects) – part 4

	Sample 1		Sample 2		Sample 1		Sample 2	
Patent (0/1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Patents	.016*** (.001)	.013*** (.001)			.016*** (.001)	.013*** (.001)		
Secrecy	-.0007 (.0009)	-.0006 (.0009)			-.0005 (.0009)	-.0004 (.0009)		
Strategic management					-.003** (.001)	-.004** (.001)	-.010* (.005)	-.010** (.005)
Inventive step ('new to the market') (0/1)	.005** (.002)	.006*** (.002)	.029*** (.006)	.025*** (.006)	.006*** (.002)	.006*** (.002)	.032*** (.007)	.027*** (.006)
Any R&D (0/1)	.012*** (.002)	.009*** (.003)	.038*** (.009)	.026** (.011)	.012*** (.002)	.009 (.003)	.039*** (.010)	.026** (.011)
Trademark (0/1)	.045*** (.007)	.054*** (.008)	.148*** (.017)	.152*** (.019)	.045*** (.007)	.053*** (.008)	.153*** (.018)	.155*** (.019)
Exporter (0/1)	.006** (.002)	.004* (.002)	.035*** (.007)	.020*** (.006)				
Ln Employment	.007*** (.002)	.010*** (.002)	.012** (.006)	.028*** (.006)	.008*** (.002)	.011*** (.002)	.019*** (.006)	.033*** (.006)
Business group member	.014*** (.003)	.015*** (.003)	.041*** (.008)	.039*** (.008)	.016*** (.003)	.016*** (.003)	.050*** (.009)	.044*** (.008)
Ln Age	.001 (.001)	.0007 (.001)	.004 (.004)	-.001 (.004)	.002 (.001)	.001 (.001)	.008* (.004)	.0002 (.004)
Share employees science & engineering	.0001*** (.0000)	.0001*** (.0000)	.0004*** (.0001)	.0004*** (.0001)	.0001*** (.0000)	.0001*** (.0000)	.0004*** (.0001)	.0005*** (.0001)
Foreign owned	-.0003 (.001)	-.001 (.001)	.004 (.006)	-.003 (.005)	.001 (.002)	-.0001 (.001)	.014** (.006)	.001 (.005)
Any form of cooperation	.007*** (.002)	.005*** (.002)	.025*** (.006)	.017*** (.005)	.008*** (.002)	.006*** (.002)	.027*** (.006)	.018*** (.005)
Constraint to innovation: market dominated by established businesses	-.001 (.001)	-.0008 (.001)	-.005 (.003)	-.003 (.003)	-.001 (.001)	-.0008 (.001)	-.005 (.003)	-.003 (.003)
Constraint to innovation: direct cost	-.0006 (.001)	-.0006 (.001)	-.002 (.003)	-.002 (.003)	-.0005 (.001)	-.0006 (.001)	-.001 (.003)	-.002 (.003)
Constraint: financing	-.002** (.001)	-.002** (.001)	-.003 (.003)	-.004 (.003)	-.002** (.001)	-.002** (.001)	-.004 (.003)	-.005* (.003)
Constraint: uncertainty	.002* (.001)	.001 (.001)	.008** (.004)	.005 (.003)	.002* (.001)	.002 (.001)	.008** (.004)	.005 (.003)
Market concentration Herfindahl index (SIC 3-digit level)	-.048 (.034)	-.093* (.056)	-.212** (.102)	-.324* (.169)	-.043 (.034)	-.094* (.055)	-.200* (.105)	-.337* (.176)
R&D intensity (SIC 3-digit level)	.0003* (.0002)	-.0003 (.0003)	.002** (.0006)	-.0002 (.0008)	.0003* (.0002)	-.0004 (.0003)	.002*** (.000)	-.0001 (.0008)
High-tech (0/1)	.017*** (.005)		.064*** (.016)		.018*** (.005)		.067*** (.017)	
% correctly predicted	73.5	66.8	73.5	68.3	73.4	66.8	73.6	68.2
% correctly predicted p=1	40.7	43.4	33.7	41.4	40.6	43.8	33.5	41.2
% correctly predicted p=0	75.7	68.4	77.8	71.2	75.7	68.3	77.8	71.1
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes		Yes		Yes
# Observations	8,145	7,418	5,550	5,144	8,142	7,416	5,550	5,144

Note: standard errors clustered by firm

Table 27 contains further results (for Sample 1) when we use the difference in a firm's ratings of patents and secrecy. As explained in Section 5, the difference between the two self-reported measures may be more reliable because they are internally consistent. The results show that the associated coefficients are statistically significant and positive. This implies that a firm's patenting propensity increases as firms value patents relatively more than secrecy as a protection mechanism.

Table 27: Logit regression results (marginal effects) – part 5

Patent (0/1)	(1)	(2)
Patents -Secrecy	.015*** (.001)	.011*** (.001)
Inventive step ('new to the market') (0/1)	.018*** (.003)	.015*** (.003)
Any R&D (0/1)	.021*** (.003)	.014*** (.003)
Trademark (0/1)	.085*** (.011)	.086*** (.012)
Ln Employment	.010*** (.003)	.015*** (.003)
Business group member (0/1)	.026*** (.004)	.024*** (.004)
Ln Age	.002 (.002)	-.0001 (.002)
Share employees science & engineering	.0001*** (.0000)	.0002*** (.0000)
Foreign owned (0/1)	.005* (.003)	.0006 (.002)
Any form of cooperation (0/1)	.015*** (.003)	.010*** (.002)
Constraint to innovation: market dominated by established businesses	-.001 (.001)	-.001 (.001)
Constraint to innovation: direct cost	.001 (.001)	.0009 (.001)
Constraint: financing	-.001 (.001)	-.002 (.001)
Constraint: uncertainty	.005*** (.002)	.004** (.001)
Market concentration Herfindahl index (SIC 3-digit level)	-.071 (.046)	-.141* (.079)
R&D intensity (SIC 3-digit level)	.001 (.0003)	-.0003 (.0004)
High-tech (0/1)	.033*** (.009)	
% correctly predicted	73.3	66.8
% correctly predicted p=1	36.8	42.9
% correctly predicted p=0	75.8	68.4
CIS dummy	Yes	Yes
Industry FE (SIC2)		Yes
# Observations	8,145	7,418

Note: Standard errors clustered by firm

The Appendix contains results for a number of specifications of the basic model shown in Equation (1), limiting the sample for manufacturing firms. Overall, the results are consistent with the full sample and thus not discussed here. In addition, Table A2-2 in the Appendix also reports results of a bivariate probit which estimates firms' decision to patent or to opt for secrecy jointly. The results suggest that the null hypothesis of independence of these decisions cannot be rejected, which corroborates our approach of estimating a firm's decision to patent or to rely on secrecy as formulated in Equation (1).

Finally, Table 28 provides some results when we use the panel dimension of the data (we use only Sample 1). For this purpose, we limit the dataset to firms that have been sampled in at least two CIS waves. As can be seen in the upper panel of Table 21, this reduces the sample to 1,549 firms, which corresponds to 16% of the regression sample or 5% of the overall sample used in Section 4. The results shown in column (1) are broadly consistent with the results shown so far. However, in column (2) we show results when employing firm-level fixed effects. These results suggest that a firm's perception of the importance of patents is no longer statistically significant. This may be explained by the fact that there is very little variation over time available to identify the estimated parameter. This is likely to be the case if firms' perceptions change only slowly over time. In effect, once we include firm-specific effects, these 'soak up' the variation in perceptions across firms that drove the results in the cross-sections.

Columns (3)-(6) report results for a dynamic specification that allows a firm's patent applications in time period t-1 to affect patent applications in time t. The lag of patents is positive and statistically highly significant in columns (3) and (5), but reverses its sign once we account for firm-level fixed effects (columns (4) and (6)). Given that the patent dummy is a very noisy measure of the underlying patenting activity, there is regression to the mean once average firm behaviour is controlled for using firm fixed effects, which explains the sign reversal.

Table 28: OLS regression results – using panel dimension

Patent (0/1)	(1)	(2)	(3)	(4)	(5)	(6)
Lag Patent (0/1)			.543*** (.038)	-.454*** (.085)	.502*** (.039)	-.438*** (.091)
Secrecy	-.003 (.005)	-.007 (.008)			-.004 (.005)	-.027 (.036)
Patents	.072*** (.007)	-.001 (.007)			.033*** (.006)	.022 (.029)
Any R&D (0/1)	.069*** (.015)	.027 (.026)	.019 (.015)	.058 (.158)	.008 (.016)	.072 (.162)
Inventive Step (0/1)	.053 *** (.012)	.001 (.014)	.048*** (.014)	.063 (.060)	.034** (.015)	.063 (.063)
Ln Employment	.139*** (.021)	.056 (.039)	.070*** (.020)	-.008 (.202)	.070*** (.020)	.003 (.209)
Ln Age	.023** (.010)	.026 (.044)	-.002 (.011)	.332 (.374)	-.003 (.011)	.345 (.385)
High-tech (0/1)	.090*** (.030)		.079*** (.027)		.076*** (.027)	
Constant	-.110*** (.031)	.032 (.118)	-.019 (.034)	-.901 (1.125)		-.943 (1.164)
R2	0.170	0.056	0.411	0.088	0.424	0.061
Industry FE (SIC2)					Yes	
Firm FE		Yes		Yes		Yes
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes
# Observations	3,009	3,009	1,480	1,480	1,480	1,480

Note: Standard errors clustered by firm

6.2 Innovative performance

This section analyses directly the relationship between a firm's choice to patent an innovation (and maintaining it as secret) and its (innovative) performance.

Tables 29 and 30 show results for the analysis of the relationship between innovative performance and a firm's decision to patent. We treat the dependent variable as a continuous variable which permits us to estimate the regression using OLS, which makes the interpretation of the variables relatively straightforward.[20]

Table 29 shows the results when we consider only product innovations that are 'new to the market', which we consider to be 'true' innovations that could in principle all be patentable. The most salient finding is the large positive coefficient associated with the patent dummy variable, which suggests a strong positive association between a firm´s decision to rely on a patent and its performance in terms of share in turnover due to an innovation reflecting the descriptive findings shown in Table 17. This in fact suggests that formal IP in the form of patents assists firms in marketing an innovation. This finding is particularly interesting in combination with the fact that there appears to be no statistically significant association between trademarking and innovative performance conditional on patenting and a range of other variables.

[20] Standard errors are robust to heteroskedasticity and clustered by firm.

Table 29: OLS regression results – innovative performance regression (product innovators only)

% turnover due to innovation **new to market**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Patent (0/1)	4.125*** (1.072)	3.527*** (1.051)	3.602*** (1.076)	3.067*** (1.053)	6.198*** (1.098)	4.958*** (1.075)
Trademark (0/1)	.536 (.822)	.445 (.805)	.542 (.820)	.495 (.803)	1.387* (.818)	1.248 (.803)
Ln Age	-4.297*** (.398)	-3.887*** (.401)	-4.377*** (.400)	-3.917*** (.401)	-4.457*** (.409)	-4.032*** (.410)
Employment	-2.720*** (.552)	-2.327*** (.567)	-2.786*** (.554)	-2.373*** (.570)	-2.370*** (.560)	-1.681*** (.579)
Business group (0/1)	-.704 (.550)	-.615 (.534)	-.599 (.551)	-.502 (.535)	-.176 (.566)	-.027 (.548)
Foreign owned (0/1)	-.337 (.450)	-.233 (.447)	-.401 (.452)	-.295 (.448)	-.160 (.462)	-.128 (.458)
Exporter (0/1)					-.186 (.491)	-.763 (.497)
High-tech (0/1)	.374 (.895)		.817 (.886)		1.871** (.883)	
Informal IP	3.078*** (.279)	2.661*** (.280)				
Formal IP	.096 (.257)	.250 (.261)				
Secrecy			1.991*** (.218)	1.763*** (.221)		
Patents			.829*** (.230)	.804*** (.235)		
Patents-Secrecy					-.623*** (.187)	-.556*** (.190)
Constant	15.927 (1.235)	5.576 (2.758)	17.331 (1.246)	5.031 (3.220)	20.081 (1.283)	9.482 (3.064)
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE		Yes		Yes		Yes
R2	0.068	0.093	0.064	0.090	0.044	0. 076
# Observations	7,788	7,788	7,788	7,788	7,788	7,788

Note: standard errors clustered by firm

Table 30 shows the results when we consider only product innovations that are ‘new to the firm’. These are likely to be imitations of existing innovations and therefore far less patentable than innovations that are considered to be ‘new to the market’. This is reflected in the results shown in Table 30 as the patent dummy is not statistically significant in any of the specifications shown. This means that the share of turnover generated with products that are derived from innovations that are only ‘new to the firm’ is not associated in a statistically significant way with a firm’s observed patent behaviour. This is particularly interesting given that the coefficients associated with the other regressors display the same signs as in Table 29 where we use the share in turnover due to product innovations that are ‘new to the market’. This suggests, therefore, that patents do not play any role for a firm’s sales based on more imitative products, as one would expect. The Appendix contains also results when we employ Sample 2, i.e. we limit the analysis to firms that patent and/or rely on secrecy to protect an innovation (Table A2-5 and A2-6). The results are qualitatively the same as the ones displayed in Tables 29 and 30, lending credibility to the interpretation that patenting a product innovation that is 'new to the market' instead of maintaining it as secret assists firms in generating a large share in sales due to innovations. An alternative interpretation is that when the firm expects sales success from a product, it is more likely to patent the invention.

Table 30: OLS regression results - innovative performance regression (product innovators only)

% turnover due to innovation **new to the firm**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Patent (0/1)	.557 (.903)	.273 (.911)	.828 (.916)	.534 (.920)	.958 (.909)	.517 (.917)
Trademark (0/1)	.613 (.753)	.669 (.761)	.502 (.748)	.542 (.755)	.574 (.748)	.584 (.755)
Ln Age	-6.265*** (.463)	-6.325*** (.474)	-6.270*** (.463)	-6.335*** (.474)	-6.116*** (.463)	-6.149*** (.473)
Employment	-1.815*** (.539)	-1.633*** (.557)	-1.833*** (.540)	-1.629*** (.557)	-1.327** (.549)	-1.086* (.564)
Business group (0/1)	-.980* (.559)	-.872 (.565)	-.954* (.558)	-.839 (.564)	-.756 (.565)	-.624 (.571)
Foreign owned (0/1)	.044 (.492)	-.133 (.494)	.067 (.493)	-.117 (.494)	.472 (.500)	.323 (.503)
Exporter (0/1)					-1.711*** (.510)	-1.966*** (.518)
High-tech (0/1)	1.408* (.856)		1.563* (.850)		1.660* (.849)	
Informal IP	.547** (.275)	.505* (.278)				
Formal IP	-.520** (.259)	-.648** (.267)				
Secrecy			.417* (.228)	.390* (.230)		
Patents			-.488** (.220)	-.626*** (.228)		
Patents-Secrecy					-.438** (.190)	-.488** (.192)
Constant	32.351 (1.485)	39.568 (10.377)	32.526 (1.477)	39.298 (10.470)	32.569 (1.454)	39.241 (11.241)
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE		Yes		Yes		Yes
R2	0.065	0.073	0.065	0.073	0.066	0. 074
# Observations	7,995	7, 995	7, 995	7, 995	7,995	8,071

Note: standard errors clustered by firm

Finally, Table 31 uses a different performance measure to look at the link between performance and a firm's choice between formal and informal IP from a different angle. Table 31 uses a firm's average annual growth rate between 1998 and 2006 as the dependent variable. We note that this does not imply that the sample consists of only firms that have been sampled in all CIS waves. We rely on the BSD data to construct the employment growth measure, which in principle is available for all firms if they existed throughout the nine-year period. The results suggest a statistically significantly positive association between patenting and employment growth. Consistently with intuition, we find older firms to grow slower and growth to be negatively correlated with initial size. The only other variable that is statistically significant is the dummy variable indicating whether a firm is part of a business group, which suggests that such firms grow faster than standalone companies.

Table 31: OLS regression results - performance regression (product innovators only): Employment growth

Employment growth 1998-2006	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Patent (0/1)	**.129* (.068)**	**.200*** (.069)**	**.141** (.071)**	**.200*** (.071)**	**.126* (.070)**	**.200*** (.071)**
Trademark (0/1)	.138** (.066)	.083 (.067)	.122* (.064)	.075 (.066)	.113* (.061)	.073 (.062)
Ln Age	-.134** (.053)	-.091* (.054)	-.137** (.053)	-.092* (.054)	-.135** (.053)	-.092* (.055)
Inventive step (‘new to the market’) (0/1)	.034 (.041)	.030 (.040)	.037 (.040)		.026 (.038)	.033 (.037)
Exporter (0/1)					-.065 (.065)	-.079 (.077)
Business group (0/1)	.330*** (.063)	.326*** (.064)	.329*** (.063)	.326*** (.064)	.329*** (.063)	.328*** (.064)
Foreign owned (0/1)	-.008 (.037)	.008 (.039)	-.003 (.036)	.010 (.038)	.002 (.035)	.017 (.036)
High-tech (0/1)	.025 (.095)		.032 (.095)		.026 (.095)	
Informal IP	.027 (.021)	.026 (.025)				
Formal IP	-.061*** (.022)	-.027 (.023)				
Secrecy			.020 (.018)	.019 (.018)		
Patents			-.049** (.022)	-.016 (.025)		
Patents-Secrecy					-.035** (.017)	-.016 (.018)
Initial size (employment 1998)	-.211*** (.032)	-.220*** (.032)	-.211*** (.032)	-.220*** (.032)	-.207*** (.033)	-.214*** (.032)
Constant	1.426 (.233)	1.115 (.391)	1.430 (.233)	1.100 (.400)	1.426 (.236)	1.123 (.424)
CIS dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE		Yes		Yes		Yes
R2	0. 128	0.159	0.128	0.159	0.127	0. 159
# Observations	2,513	2,513	2,513	2,513	2,513	2,513

7. Policy Implications

This report provides an analysis of the determinants of a firm´s patenting decision and assesses potential implications of the choice on its innovative performance measured in terms of turnover and employment growth due to innovation. The analysis relies on a new integrated dataset that combines a range of data sources into a panel at the enterprise level. Our findings suggest the following conclusions and policy implications with regard to (a) future data collection, (b) a firm's decision to patent or to rely on informal IP, and (c) the relation between this decision to patent and (innovative) performance.

Data

A significant improvement in conducting the Fifth Community Innovation survey (CIS 5) over the Fourth (CIS 4) was the large overlap in samples between CIS 4 and 5 in comparison with CIS 3 and 4 (see Table 2). Such overlap is a necessary condition for researchers' ability to construct longitudinal datasets. Despite our efforts to construct a panel containing firms observed over several time periods, the number of firms sampled in all three waves was too small to use statistical methods that rely on variation in the data over time to account for unobserved heterogeneity across firms. We would, therefore, welcome the incorporation of such analytical concerns in the construction of future CIS sampling frames in the UK.

Determinants of a firm´s choice of IP protection

Our descriptive analysis shows that about 53% of firms in the sample conduct some form of research and development. However, only about 22% of firms report having a product innovation and only 14% a process innovation during a three year period. Only about 30% of firms report any form of innovation. Strikingly, we find that only 1.3% of firms in the sample patent and even among firms that conduct R&D, only 2% patent. In particular, the share of patenting firms is much lower than what one might expect given that nearly 24% of firms report product innovations. Even when restricted to innovating firms, the patenting rate is only 6%.

When we investigated the determinants of patenting versus not patenting for innovative firms (considering innovation as a pre-condition for patenting), we found that most of the predictor variables confirmed prior intuition: patentees are product innovators rather than process innovators, larger, older, more likely to also use trademarks, more R&D-intensive, more technological and they are more likely to export. We also found that firm attitudes towards patenting and secrecy were not correlated conditionally on these characteristics, which suggests that these are not either/ or choices.

What then explains the fact that fewer than half the firms patent, even if we restrict ourselves to new to the market product innovators that do R&D? One possible reason is that the samples we are using contain a large number of smaller firms (<250 employees) who may find use of the formal IP system simply too costly. This hypothesis is weakly supported by the negative coefficient on the presence of financial constraints in the patent propensity regression. However, looking at the large sample (which includes sectors that generally do not have patentable inventions), we can see that almost half of the large firms do not use formal or informal IP either. Because firms that use one IP mechanism are more likely to use another, another possibility is that firms have a 'propensity' to use or not use IP, and that the problem is lack of familiarity with the system and sub-optimal behaviour on the part of some firms.

A final (and perhaps the most likely) explanation is that the use of any IP protection mechanism costs time and money and most firms find that the benefits do not exceed the costs, especially in the case of patents.

The use of IP protection and (innovative) performance

The results on innovation performance and firm growth do suggest quite strongly that patented innovations are more successful in promoting both of these. However, because we do not know whether performance and patenting are both driven by the quality of the firm's innovation, it is not possible to make a causal inference based on our analysis that patenting any innovation will lead to better sales performance and growth.

Appendix

A1 – Descriptive statistics using un-weighted data

Table A1-1: Sample distribution across firm size categories

Firm size category	CIS 3	CIS 4	CIS 5	All
	# firms	# firms	# firms	# firms
Small	5,108	9,248	8,406	22,762
Medium	1,670	3,759	3,293	8,722
Large	1,292	3,092	2,892	7,276

Table A1-2: Sample distribution across sectors

Sector	CIS 3		CIS 4		CIS 5		All	
	# Firms	%	# Firms	%	# Firms	%	# Firms	%
High-tech	382	4.73	447	2.78	319	2.19	1,148	2.96
Medium-tech	781	9.68	1,128	7.01	1,029	7.05	2,938	7.58
Other manufacturing	2,211	27.04	3,196	19.85	3,233	22.16	8,640	22.29
Non-manufacturing	4,643	57.53	11,094	68.91	9,891	67.79	25,628	66.12
R&D services	53	0.66	234	1.45	119	0.82	406	1.05

Notes: (1) High-tech: pharmaceuticals SIC 2423; aircraft & spacecraft SIC 353; medical, precision & optimal instruments SIC 33; radio, television & communication equipment SIC 32; office, accounting & computing machinery SIC 30;
(2) Medium-tech: electrical machinery & apparatus SIC 31; motor vehicles, trailers & semi-trailers SIC 34; railroad & transport equipment SIC 352 & SIC 359; chemical & chemical products SIC 24 (excl. SIC 2423); machinery & equipment SIC 29;
(3) R&D services: SIC 73

Table A1-3: Distribution of innovative activities

	Any R&D	Product innovation	Process innovation	Product & process innovation
	Yes	Yes	Yes	
CIS 3	41.38%	12.72%	9.30%	9.94%
CIS 4	59.51%	17.65%	7.43%	13.90%
CIS 5	68.04%	16.41%	4.79%	11.08%
All	58.94%	16.13%	6.82%	12.01%

Table A1-4: Distribution of IP activities

	% Patents	% Trademarks
CIS 3	2.86% (231)	5.01% (404)
CIS 4	2.80% (451)	5.10% (821)

CIS 5	2.12% (309)	4.17% (609)
All	**2.56% (991)**	**4.73% (1,834)**

Note: number of firms in brackets

Table A1-5: Protection mechanisms

Protection mechanism	**CIS 3**				**CIS 4**				**CIS 5**			
	No	Low	Medium	High	No	Low	Medium	High	No	Low	Medium	High
Registered IP	80.84% (6,524)	9.36% (755)	6.29% (508)	3.51% (283)	74.61% (12,012)	12.91% (2,078)	8.08% (1,301)	4.40% (708)	71.35% (10,410)	13.29% (1,939)	8.74% (1,275)	6.63% (967)
Patent	82.55% (5,101)	4.94% (305)	5.02% (310)	7.49% (463)	79.19% (12,177)	7.63% (1,173)	6.00% (923)	7.17% (1,103)	75.06% (9,495)	9.19% (1,162)	5.92% (749)	9.83% (1,244)
Trademark	75.87% (4,690)	6.71% (415)	8.15% (504)	9.27% (573)	74.01% (11,382)	8.86% (1,363)	8.84% (1,359)	8.28% (1,274)	67.29% (8,524)	10.03% (1,270)	10.12% (1,282)	12.57% (1,592)
Registered design	83.25% (5,125)	5.75% (354)	5.44% (335)	5.56% (342)	78.38% (12,052)	8.67% (1,333)	7.18% (1,104)	5.77% (887)	72.38% (9,160)	10.10% (1,278)	8.54% (1,081)	8.98% (1,136)
Unregistered IP Copyright	78.42% (4,820)	7.79% (479)	6.56% (403)	7.22% (444)	76.15% (11,709)	9.65% (1,484)	7.50% (1,154)	6.70% (1,030)	71.11% (8,988)	10.09% (1,275)	8.17% (1,033)	10.63% (1,343)
Informal IP	67.31% (5,432)	12.87% (1,039)	13.44% (1,085)	6.37% (514)	57.34% (9,231)	18.54% (2,985)	17.03% (2,742)	7.09% (1,141)	54.69% (7,980)	18.66% (2,723)	17.99% (2,625)	8.66% (1,263)
Secrecy	65.51% (4,054)	10.49% (649)	12.15% (752)	11.85% (733)	61.95% (9,526)	13.30% (2,045)	13.91% (2,139)	10.85% (1,668)	57.00% (7,212)	14.55% (1,841)	15.51% (1,963)	12.94% (1,637)
Lead-time	63.84% (3,959)	9.16% (568)	13.63% (845)	13.37% (829)	61.21% (9,411)	12.43% (1,912)	14.95% (2,298)	11.41% (1,755)	56.23% (7,121)	11.75% (1,488)	17.00% (2,153)	15.02% (1,902)
Complexity	70.32% (4,335)	11.39% (702)	11.29% (696)	7.01% (432)	67.34% (10,355)	14.34% (2,205)	12.53% (1,927)	5.79% (890)	65.18% (8,246)	14.60% (1,847)	13.49% (1,706)	6.73% (852)
Confidentiality	65.37% (4,053)	9.77% (606)	11.24% (697)	13.61% (844)	62.05% (9,542)	11.14% (1,713)	13.41% (2,062)	13.40% (2,060)	53.20% (6,755)	11.95% (1,518)	15.85% (2,012)	19.00% (2,413)

Notes: (1) ‘No’ corresponds to ‘not used’; (2) number of firms in brackets.

Table A1-6: Protection mechanisms

	Formal IP			
	Not used	**Low**	**Medium**	**High**
No patent	99.37% (28,764)	95.91% (4,577)	89.75% (2,768)	84.78% (1,660)
Patent	0.63% (182)	4.09% (195)	10.25% (316)	15.22% (298)
Total	100% (28,946)	100% (4,772)	100% (3,084)	100% (1,958)
	Informal IP			
	Not used	**Low**	**Medium**	**High**
No patent	99.40% (22,507)	97.63% (6,587)	93.83% (6,054)	89.82% (2,621)
Patent	0.60% (136)	2.37% (160)	6.17% (398)	10.18% (297)
Total	100% (22,643)	100% (6,747)	100% (6,452)	100% (2,918)

Note: number of firms in brackets

Table A1-7: Protection mechanisms

	Informal IP				
	Not used	**Low**	**Medium**	**High**	**Total**
Process innovation					
No patent	25.92% (1,691)	25.09% (1,637)	32.09% (2,094)	16.90% (1,103)	100% (6,525)
Patent	2.22% (10)	12.86% (58)	48.78 % (220)	36.14% (163)	100% (451)
Product innovation					
No patent	24.93% (2,364)	24.78% (2,349)	33.28% (3,155)	17.01% (1,613)	100% (9,481)
Patent	2.83% (19)	14.31% (96)	46.35% (311)	36.51% (245)	100% (671)
Product innovation new to the firm					
No patent	26.06% (1,415)	27.61% (1,499)	32.20% (1,748)	14.13% (767)	100% (5,429)
Patent	4.17% (13)	16.67% (52)	48.08% (150)	31.09% (97)	100% (312)
Product innovation new to the market					
No patent	15.56% (671)	21.60 (931)	38.60% (1,664)	24.24% (1,045)	100% (4,311)
Patent	1.24% (6)	13.20% (64)	45.36% (220)	40.21% (195)	100% (485)

Note: number of firms in brackets

Table A1-8: Inventive step and protection methods

		Size of inventive step			
		New to the firm		**New to the market**	
		No	Yes	No	Yes
Formal IP	Not used	46.86% (1,417)	53.28% (3,059)	61.78% (3,550)	39.18% (1,879)
	Used	53.14% (1,607)	46.72% (2,682)	38.22% (2,196)	60.82% (2,917)
CIS Patent*	Not used	54.45% (1,592)	62.87% (3,579)	70.26% (3,877)	48.01% (2,252)
	Used	45.55% (1,332)	37.13% (2,114)	29.74% (1,641)	51.99% (2,439)
UK/ EPO Patent**	No	93.15% (2,817)	94.57% (5,429)	96.76% (5,560)	89.89% (4,311)
	Yes	6.85% (207)	5.43% (312)	3.24% (186)	10.11% (485)
Informal IP	Not used	26.39% (798)	24.87% (1,428)	35.19% (2,022)	14.12% (677)
	Used	73.61% (2,226)	75.13% (4,313)	64.81% (3,724)	85.88% (4,119)
Secrecy	Not used	34.61% (1,015)	35.01% (1,993)	44.09% (2,435)	22.94% (1,079)
	Used	65.39% (1,918)	64.99% (3,700)	55.91% (3,088)	77.06% (3,625)

Note: (1) number of firms in brackets; (2) The variables formal IP, CIS patent, Informal IP and secrecy were reduced to binary variables indicating either 'no use' or 'use' which includes the three categories: low, medium, and high importance.

* Self-reported importance attributed to patents as protection mechanism
** Dummy variable indicating whether firm holds patent

Table A1-9: Turnover due to product innovation and protection methods

	% Turnover due to product innovation				Total
	0%	<10%	≥10%-25%<	≥25%	
New to the firm					
Patents					
Not used	27.14 % (1,442)	23.96% (1,273)	30.00% (1,594)	18.91% (1,005)	100% (5,314)
Low	23.72 % (269)	25.75% (292)	33.33% (378)	17.20% (195)	100% (1,134)
Medium	23.64% (231)	25.69% (251)	33.98% (332)	16.68% (163)	100% (977)
High	27.11% (437)	26.18% (422)	31.02% (500)	15.69% (253)	100% (1,612)
Secrecy					
Not used	30.10% (870)	23.49% (679)	28.62% (827)	17.79% (514)	100% (2,890)
Low	24.17% (427)	26.94% (476)	31.58% (558)	17.32% (306)	100% (1,767)
Medium	23.49 % (533)	25.39% (576)	32.39% (735)	18.73% (425)	100% (2,269)
High	26.00% (553)	24.07% (512)	32.44% (690)	17.49% (372)	100% (2,127)
New to the market					
Patents					
Not used	56.04% (2,850)	15.79% (803)	17.79% (905)	10.38% (528)	100% (5,086)
Low	41.15% (465)	25.75% (291)	23.19% (262)	9.91% (112)	100% (1,130)
Medium	38.45% (371)	24.56% (237)	24.87% (240)	12.12% (117)	100% (965)
High	32.42% (522)	28.26% (455)	23.54% (379)	15.78% (254)	100% (1,610)
Secrecy					
Not used	60.78% (1,672)	15.70% (432)	14.79% (407)	8.72% (240)	100% (2,751)
Low	50.27% (844)	21.20% (356)	19.89% (334)	8.64% (145)	100% (1,679)
Medium	42.30% (951)	21.89% (492)	23.67% (532)	12.14% (273)	100% (2,248)
High	35.18% (749)	23.95% (510)	24.00% (511)	16.86 (359)	100% (2,129)

Note: number of firms in brackets

A2 – Supplementary regression results

Table A2-1: Correlation matrix for formal and informal IP measures

	Design	TM	Patent	Confidentiality	Copyright	Secrecy	Complexity
Design	1.000						
Trademark	0.691	1.000					
Patent	0.716	0.663	1.000				
Confidentiality	0.608	0.614	0.562	1.000			
Copyright	0.455	0.487	0.494	0.532	1.000		
Secrecy	0.437	0.453	0.468	0.477	0.674	1.000	
Complexity	0.480	0.424	0.470	0.463	0.513	0.624	1.000
Lead-time	0.389	0.385	0.385	0.391	0.493	0.573	0.627

Note: All correlations statistically significant at 1% level.

Table A2-2: Bivariate probit regression results

	(1) Patent (0/1)	(2) Secrecy (0/1)	(3) Parameter homogeneity test	(4) Patent (0/1)	(5) Secrecy (0/1)	(6) Parameter homogeneity test
Informal IP	.099*** (.032)	1.686*** (.032)	1338.28 (.000)	.076*** (.028)	1.694*** (.002)	1384.36 (.000)
Formal IP	.438*** (.023)	.179*** (.028)	49.77 (.000)	.431*** (.024)	.186*** (.028)	44.64 (.0000)
Ln Employment	.565*** (.051)	.341*** (.060)	21.48 (.000)	.549*** (.051)	.345*** (.060)	19.23 (.000)
Ln Age	.129*** (.036)	-.009 (.026)		.129*** (.036)	-.007 (.026)	
Inventive step ('new to the market') (0/1)				.295*** (.051)	-.098** (.045)	96.93 (.000)
Product innovator	.322*** (.079)	.009 (.047)	62.74 (.000)			
Any R&D (0/1)	.568*** (.142)	.174** (.072)		.561*** (.143)	.177** (.072)	
High-tech (0/1)	.457*** (.075)	-.306*** (.089)		.453*** (.0755)	-.302*** (.089)	
ρ (st. error)	.051 (.054)			.059 (.054)		
Wald (ρ=0)	1.194 (.274)			.885 (.347)		
CIS dummies	Yes	Yes		Yes	Yes	
# Observations	10,641			10,641		

Note: Standard errors clustered by firm; ρ indicates the interrelatedness of the two probit models estimated jointly. The results of testing the null hypothesis of parameter homogeneity across the two probit regressions are reported in columns (3) and (4). These tests are conducted jointly for groups of variables.

Table A2-3: Logit regression results (marginal effects) – manufacturing firms

Patent (0/1)	(1)	(2)	(3)	(4)
Informal IP	-.0009 (.003)	-.002 (.003)		
Registered IP	.040***	.034***		

	(.003)	(.003)		
Patents			.038*** (.002)	.033*** (.002)
Secrecy			-.003 (.002)	-.002 (.002)
Inventive step ('new to the market') (0/1)	.025*** (.006)	.022*** (.005)	.017*** (.005)	.016*** (.005)
Ln Employment	.062*** (.007)	.069*** (.008)	.054*** (.007)	.060*** (.007)
Ln Age	.013*** (.005)	.010** (.004)	.011*** (.004)	.010** (.004)
Any R&D (0/1)	.046*** (.006)	.042*** (.005)	.038*** (.005)	
High-tech (0/1)	.038*** (.010)		.025*** (.008)	
% correctly predicted	93.3	92.1	93.2	92.3
% correctly predicted p=1	10.8	17.3	10.5	16.5
% correctly predicted p=0	98.9	97.3	98.9	97.5
CIS dummies	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes
# Observations	5,029	4,984	5,029	4,984

Note: Standard errors clustered by firm

Table A2-4: Logit regression results (marginal effects) – manufacturing firms

	Sample 1		Sample 2	
Patent (0/1)	**(1)**	**(2)**	**(3)**	**(4)**
Patents	.032*** (.002)	.026*** (.002)		
Secrecy	-.005 (.002)	-.004** (.002)		
Inventive step ('new to the market') (0/1)	.012*** (.004)	.011*** (.004)	.044*** (.011)	.037*** (.010)
Ln Employment	.026*** (.005)	.031*** (.006)	.060*** (.015)	.080*** (.014)
Ln Age	.007* (.003)	.005 (.003)	.017* (.009)	.010 (.008)
Any R&D (0/1)	.031*** (.005)	.028*** (.004)	.076*** (.016)	.067*** (.013)
Trademark (0/1)	.097*** (.015)	.111*** (.016)	.202*** (.027)	.232*** (.028)
Business group (0/1)	.029*** (.007)	.026*** (.006)	.070*** (.015)	.059*** (.014)
Share employees science & engineering	.0003*** (.000)	.0002*** (.0000)	.0009** (.0004)	.0006** (.0003)
High-tech (0/1)	. 021*** (.008)		.054*** (.019)	
% correctly predicted	87.8	87.5	85.0	84.2
% correctly predicted p=1	28.2	32.6	21.7	30.0
% correctly predicted p=0	91.9	91.2	91.7	90.0
CIS dummies	Yes	Yes	Yes	Yes
Industry FE (SIC2)		Yes		Yes
# Observations	4,738	4,695	3,425	3,399

Note: Standard errors clustered by firm

Table A2-5: OLS regression results – innovative performance regression (product innovators only) – Sample 2

% turnover due to innovation **new to market**	(1)	(2)	(3)	(4)
Patent (0/1)	4.960*** (1.094)	4.061*** (1.080)	5.002*** (1.100)	4.124*** (1.082)
Trademark (0/1)	.811 (.886)	.795 (.871)	.827 (.887)	.837 (.871)
Ln Age	-5.570*** (.514)	-4.955*** (.514)	-5.531*** (.517)	-4.869*** (.517)
Ln Employment	-2.733*** (.637)	-2.341*** (.661)	-2.628 (.649)	-2.103*** (.678)
Business group (0/1)	.111 (667)	.291 (.648)	.164 (.672)	.416 (.654)
Foreign owned (0/1)	.105 (.564)	.103 (.554)	.205 (.569)	.320 (.562)
Exporter (0/1)			-.398 (.594)	-.913 (.605)
High-tech (0/1)	.762 (.953)		.785 (.954)	
Constant	24.220 (1.612)	13.058 (3.442)	24.256 (1.615)	13.216 (3.748)
CIS dummy	Yes	Yes	Yes	Yes
Industry FE		Yes		Yes
R2	0.053	0.090	0.054	0.090
# Observations	5,559	5,559	5,559	5,559

Table A2-6: OLS regression results – innovative performance regression (product innovators only) – Sample 2

% turnover due to innovation **new to firm**	(1)	(2)	(3)	(4)
Patent (0/1)	**.032** **(.907)**	**-.177** **(.924)**	**.289** **(.910)**	**.021** **(.925)**
Trademark (0/1)	.217 (.789)	.127 (.802)	.303 (.789)	.239 (.801)
Ln Age	-5.847*** (.518)	-5.722*** (.531)	-5.609*** (.517)	-5.456*** (.529)
Ln Employment	-1.739*** (.589)	-1.643*** (.605)	-1.070* (.593)	-.896 (.609)
Business group (0/1)	-1.054* (.620)	-1.010 (.626)	-.751 (.631)	-.655 (.638)
Foreign owned (0/1)	-.589 (.559)	-.747 (.566)	.037 (.568)	-.075 (.573)
Exporter (0/1)			-2.483*** (.582)	-2.812*** (.592)
High-tech	1.873** (.950)		2.015** (.949)	
Constant	33.543 (1.698)	39.909 (10.570)	33.789 (1.701)	40.419 (11.604)
CIS Dummy	Yes	Yes	Yes	Yes
Industry FE		Yes		Yes
R2	0.065	0.076	0.067	0.079

# Observations	5,658	5,658	5,658	5,658

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