Intellectual Property Office

When do firms not use patents and trademarks to protect valuable innovations?

Evidence from the SIPU 2015 survey

Prepared for the Intellectual Property Office and carried out by:

Suma Athreye
Essex Business School
Southend on Sea, United Kingdom

Claudio Fassio
School of Economics and Management
Lund University, Sweden

September 2018

This is an independent report commissioned by the Intellectual Property Office

2018/01

Suma Athreye is Professor of Technology Strategy at Essex Business School and is a member of the Management Science and Entrepreneurship Group. Sumas main research interests lie in the fields of Economics of Innovation and International Economics and she has published over 50 papers on these subjects and won several research grants for work in these areas. She is on the Editorial Board of the academic journals Research Policy, Journal of International Business Studies, Industrial and Corporate Change, Perspectives on Globalisation and Development, International Journal of Technological Learning; Innovation and Development and Multinational Business Review. She also advises the Big Innovation Centre and the UK Intellectual Property Office on their research as member of their research advisory boards. She has consulted to the World Intellectual Property Organisation, worked closely with the UK Intellectual Property Office and was Rapporteur of the European Research Area (2008) report Opening to the world: International cooperation in Science and Technology.

Claudio Fassio is a researcher at the Sten K. Johnson Centre for Entrepreneurship of the University of Lund, Sweden. He is also a research associate at CIRCLE, University of Lund and at BRICK, University of Torino, Italy. His research interests lies in the field of Science, Technology and Innovation, with a specific focus on the interplay between innovation and internationalization strategies of firms and the collaborations between firms and universities. He has published his research in peer-reviewed international journals such as Industrial and Corporate Change, R&D Management, Industry & Innovation, Journal of Technology Transfer and others. He has won several research grants awarded by respectively the Swedish Innovation Agency (Vinnova), the Lundberg Foundation and the Jan Wallander Foundation in Sweden. He has consulted to different Swedish governmental agencies, such as the Growth Analysis (Tillväxtanalys) and Vinnova.

ISBN: 978-1-910790-33-5
When do firms not use patents and trademarks to protect valuable innovations? Evidence from the SIPU 2015 survey

Published by The Intellectual Property Office
March 2018

1 2 3 4 5 6 7 8 9 10

Any enquiries regarding this publication should be sent to:

The Intellectual Property Office
Concept House
Cardiff Road
Newport
NP10 8QQ

Tel: 0300 300 2000 Fax: 01633 817 777

e-mail: information@ipo.gov.uk

This publication is available from our website at www.gov.uk/ipo

Contents

Executive Summary

The UK IPO commissioned the Survey of Innovation and Patent Use 2015 to identify the main reasons why patents and trademarks are not used in the UK economy. The survey was designed with significant inputs from the Intellectual Property Office, Department of Business, Innovation and Skills and Innovate UK and, as in previous surveys, linked to the UK Community Innovation Survey that contains valuable information about the technological behaviours of firms. The SIPU 2015 survey collected a total of 634 responses from the firms interviewed, which represents 72% of the total number of firms included in the CIS survey that had agreed to be contacted again for SIPU 2015.

An innovative feature of SIPU 2015 is that it focussed on patent and trademark usage to protect the most valuable innovations of firms and asked a series of questions to assess the reasons why firms do not make use of formal IP in the form of patents and trademarks. The reasoning behind this is that small and large firms can be very different in the scale of innovations they produce during a three-year period. Since the most valuable innovation is very likely to be considered for protection by both groups of firms focussing on such innovations effectively puts small and large firms on a more equal footing for purposes of observation.

Our analysis revealed four interesting findings which overturn some popular assumptions in current policy.

Our first finding is that small firms are just as motivated as large firms to protect their valuable innovations with patents and trademarks. The well-known finding that small firms patent less than large firms probably reflects the fact that when innovation is on a large scale there are many more valuable innovations worth patenting. Put differently, once we focus on economically valuable innovations we do not find any significant difference in the propensity to patent between small and large firms. The same is true for trademarks. We also find that, among the innovators who did not patent, the cost of patenting is considered as an important barrier to patent only by small firms, signalling that the costs relating to the patenting process are the main barrier to small firm use of patents. It is important to stress that these costs often involve more than the application costs (which are usually quite low), but may reflect other costs related, for example, to patent litigation and other legal issues. This has the clear policy implication that small firms need help with the costs of litigating and defending their patents - and recent efforts by CIPA to provide pro bono services for litigation may be a step in the right direction.

The second finding concerns the reasons for not patenting. Approximately 50% of innovating firms (140 firms out of 277) indicated that their most valuable innovation was simply “not patentable”. The non-patentability of the innovation raises the question of the requirements for patenting: while in some cases it might simply be that the innovation mentioned is not a technological one (it could be a service or marketing innovation), so it does not fall within the range of what is legally patentable, it could also be that in some cases the overall requirements needed to obtain a patent (novelty) might discourage firms from applying for a patent. To increase the overall propensity to patent, a thorough analysis of the factors that make patenting “not possible” for some innovations would be extremely useful.

Thirdly, the lack of enforcement is seen as an important barrier to the patenting of new-to-the-market innovations by almost one quarter of SIPU firms (23%). In particular, CIS data reveal that new-to-market innovators tend to protect their innovation through trade secrecy because of this difficulty. Policy attention should be directed to understand the reasons why firms producing novel innovations have concerns about the enforceability of patents and what can be done to alleviate them.

Fourth, the reasons behind the decision not to patent an innovation are very different from the reasons for not applying for a trademark. Trademarks are not applied for when existing markets are already well protected by existing trademarks or by using alternative distribution channels. Trademark use does not display a one-to-one relationship with innovation: having an already existing trademark is the most important reason for not applying for a new one. This important difference should be taken into account in applied works that treat trademarks and patents as equal proxies for innovation.

Two other results might be of interest to managers of intellectual property. First, while openness and collaborative innovation has been shown in many studies to be inversely related to patenting and other formal IP such as trademarks, we find that this is the case only when we look at collaborative innovation along the value chain, e.g., with suppliers and clients. Open firms that engage in collaborative innovation also reported that their markets were protected by pre-existing trademarks. The reasons for not patenting (their most valuable innovations) among open firms do not, however, reveal any of the anxieties that are often assumed in the innovation management literature as typical of open firms, viz. fear of leakage/disclosure to collaborators. Taken together these results may suggest a deeper strategic concern with control over technology and markets that probably goes hand in hand with collaborative innovation.

Second, our results hint at a complementary relationship between formal and informal IP, which goes against the common assumption that considers them as alternative strategies. Our analysis shows that firms that patent are also more likely to rely on informal IP when compared to non-patenting firms. Future efforts should be directed at understanding the sources of this complementarity better which may be rooted in uncertainty about innovation value.

When do firms not use patents and trademarks to protect valuable innovations? Evidence from the SIPU 2015 survey

1. Introduction

It is well recognised since the seminal papers by Mansfield (1984) and Cohen et al (2000) that protecting innovations by intellectual property is only one method of appropriating value from an innovation. Other widely used methods of appropriating value include use of strategies such as trade secrecy, gaining lead time advantage over competitors in the marketing of products that use the innovation and the embedding of technologies in complex product designs to protect the innovations of value. Despite this, policy attention has often focussed on patenting as both an indicator of the technological health of a country and as the method of appropriation that can be most influenced by policy. In other discourses, these other strategies to appropriate value are sometimes seen as alternatives to patenting, although there is no reason at all to suppose that the use of patenting and alternative appropriation strategies are mutually exclusive (Hall et al 2014, Arora 1997).

The UK IPO commissioned the Survey of Innovation and Patent Use to identify the main barriers to IP use in the UK economy. The survey was designed by the authors but with significant discussions and input from the Intellectual Property Office, Department of Business, Innovation and Skills and Innovate UK. The survey was administered by the telephone survey team from the Office of National Statistics soon after the conclusion of the UK Community Innovation Survey. In addition, the UK CIS 2015 was also improved with specific questions enabling us to identify continuous R&D performers, firms that had received innovation support and improve our understanding of the proportion of innovations protected by firms using a range of appropriation modes viz. lead time use, complex product design, trade secrecy, design rights, copyright registration and trademark use.

The SIPU 2015 focussed on understanding the characteristics of the most valuable innovations of firms, if these innovations were protected by patents and trademarks and, if they were not, the reasons why the firms had not applied for patent or trademark protection. Appendix 1 describes the achieved sample of the survey in more detail but, here, we note that the survey was based on a sampling frame drawn from the Community Innovation Survey (CIS) conducted in 2015 covering the time period 2012-2014 and that 634 firms answered the survey (with a response rate of 72%).[1] As with SIPU 2013, we found the linking of questions in SIPU 2015 with those asked in CIS 2015 very useful in informing us of the broader innovation background and strategies of applicants. It also allowed an analysis of the average returns to innovation (for medium and large firms who usually have many innovations) with the return on their most valuable innovation. As returns to innovation are skewed, this perspective is useful in understanding the effect of policy and policy support mechanisms.

1 The size distribution of SIPU 2015 respondents is perfectly in line with the respondents from SIPU 2013: in both cases small firms with less than 50 employees represent approximately 50% of the sample, while medium (50 to 249 employees) and large firms (more than 250 employees) represent respectively 30% and 20% of the sample.

2. Comparing innovation in CIS and SIPU

In a two year period a firm may generate several innovations some of which are more valuable than others. Small firms are also likely to generate fewer innovations than large firms. The CIS asks firms to record their strategy over the totality of innovations from 2012-14. By asking firms in SIPU to focus on their most valuable innovation we are, in effect, trying to focus on the one innovation that most firms' would have the most incentive to try and protect, irrespective of size and the number of innovations.

Table 1, below, represents the simple average for the share of revenues due to innovation reported in CIS and SIPU. The two sets of figures are not strictly comparable; for example the number of firms that answered the two questions differs and 29% of the firms in SIPU (79 of 277 firms) reported that their most valuable innovation occurred before 2012, while the data from CIS pertain to the two-year period from 2012-2014.

We can see from Table 1 that the most valuable innovation probably accounts for more than half of all innovative sales on average and especially for small and medium firms. Thus, we should expect that these are innovations which firms will try their best to protect using formal intellectual property methods.

Table 1: Share of innovative sales in CIS and SIPU, all figures in %

	N	Contribution of innovation to turnover in 2014	N	Contribution of the most valuable innovation to turnover in 2014	Contribution of most valuable innovation to overall innovative sales in 2014
All firms	269	37.2	246	21.7	58.3
Small firms	142	41.4	133	28	67.6
Medium firms	89	33.1	80	16.7	50.5
Large firms	38	31.2	33	8.4	26.9

Source: SIPU 2015 merged with CIS2015

In Table 2a, below, we can also see that firms that reported using patents to protect their innovations in the CIS also tended to report using patent protection to protect their most valuable innovation and vice versa. Thus, approximately 85% of the firms lie on the diagonal in the cross tabulation matrix. A similar pattern can be seen for trademark usage in Table 2b. This suggests that firms that use patents and trademarks to protect technology and markets for their most valuable innovation are also likely to do so more generally. Thus, we can infer much concerning the overall appropriation strategies of firms from the study of the specific reasons to use (or not use) patenting and trademarking for their most valuable innovation.

Table 2a: Use of patents in CIS and SIPU

Used patents at all ↓	Patented the most valuable innovation		Total
	No	Yes	
No	**144**	7	151
Yes	29	**64**	93
	173	71	244

Source: SIPU 2015 merged with CIS2015

Table 2b: Use of trademarks in CIS and SIPU

Used trademarks at all ↓	Trademarked the most valuable innovation		Total
	No	Yes	
No	**126**	14	140
Yes	41	**37**	78
	167	51	218

Source: SIPU 2015 merged with CIS2015

3. Protecting valuable innovations

As noted earlier, when firms have an innovation of value, they can deploy a range of strategies to protect the technology and enhance the rents that accrue to the innovation. Often, firms will patent what is patentable in the technology underlying the innovation and deploy other methods of appropriating value which are observable but harder to measure. These include use of strategies such as trade secrecy, gaining lead time advantage over competitors in the marketing of products that use the innovation and the embedding of technologies in complex product designs to protect the innovations of value. When innovations are likely to result in the creation of distinct markets firms can also protect the product market for innovation by using trademarks, design rights or copyrights. Far from being alternatives, these different methods of protecting innovation value are complements and, often, firms will decide on strategies to protect their innovation based on the imitative competition they face and the nature of the innovation itself. Apart from trade secrecy, which cannot be practised at the same time as patenting for a single innovation, the methods of protecting innovation rents are not mutually exclusive.

Patents and trademarks depend upon the official grant of exclusivity in technology and product markets respectively and this makes them a distinct category amongst innovation protection strategies. Firms incur clear costs in filing for patents and trademarks and because of the official grant of exclusivity, patents and trademarks remain an important area of policy intervention by governments wishing to intervene to raise the inducement to innovate in the national economy.

3.1. Using patents to protect technology and capture innovation rents

Firms invest in R&D and acquisition of external technology to develop new products and processes. Some firms develop novel products and processes. Not all firms innovate and among the innovative firms, not all launch patentable innovations. There is a vast amount of literature that has examined the probability of patenting by different types of firms (see Cohen et al 2000 and Hall et al 2013 for comprehensive reviews). Many of these reviews find that small firms are less likely to patent and that new-to-market innovators are more likely to apply for patents.

Arora et al (2013) note that many empirical studies tend to measure the general propensity of firms to patent across their overall innovation portfolio and so are likely to be biased against small firms who have smaller innovation portfolios (think 10 innovations a year rather than 100). Furthermore, the typical distribution of the value of innovations even among a single firm's portfolio is usually skewed, with few innovations or few products often accounting for a very large share of all sales (Scherer and Haroff, 2000), so firms might implement very different strategies for innovations, according to their specific value. If one wanted to estimate a reasonable measure of the propensity to patent (an innovation) then it makes sense to focus on the most valuable innovation of the firm.

In Table 3 we compare the probability of patent and trademark use by firms in 2015 in the Community Innovation Survey (CIS9) and in the SIPU survey. The difference between the two statistics is that in the former case we report the probability that firms apply for at least a patent for all of the innovations they introduced, while in the latter we only report the probability that firms patent their most valuable innovation (regardless of what they do for their other innovations).

Table 3: Percentage of innovators applying for patents and trademarks in the CIS9 and in SIPU for their most valuable innovation

	Patents all CIS innovators (1)			Patents SIPU (2)			Trademarks all CIS innovators (3)			Trademarks SIPU (4)		
	Num.	%		Num.	%		Num.	%		Num.	%	
Total Innovating firms	2641			277			2578			277		
Total patenting firms	666	25.22		71	25.63		761	29.52		63	22.7	
Small firms (<49 employees)	197	19.58	***	35	24.8		248	25.1	***	33	23.4	
Medium firms (50-249 employees)	285	26.46	***	25	27.2		326	30.96		22	23.9	
Large Firms (> 250 employees)	184	32.97	***	11	25		187	34.82		8	18.2	
Product innovation	546	35.23	***	57	33.1	**	584	38.8	***	50	29.1	***
Process innovation	381	21.04		10	18.9		454	25.65		6	11.3	
New to Market	397	43.77	***	44	32.5	**	379	43.87	***	37	27.4	**
New to Firm	328	23.4		10	14.3		436	31.43		9	12.8	
Continuous R&D	451	38.06	***	49	34.75	***	438	38.9	***	41	29.1	***
No R&D or discontinuous R&D	215	14.77		22	16.18		323	22.25		22	16.2	
Independent firms	-	-		30	20.6					35	24	
Affiliated to a group	-	-		41	31.3	**				28	21.4	
Internally financed	-	-		46	22.1					47	22.6	
Any external finance	-	-		23	40.4	***				14	24.5	

Source: Computations from UK CIS 2015 and SIPU 2015. Notes: ** for significance at 5%; *** for significance at 1%.

Looking at the first four columns of Table 3 (which pertain to patenting) we find that even though the UK CIS sample of innovators is 10 times as large as SIPU the proportion of patenting firms do not vary much and is stable around 25%. With respect to SIPU2013 we find that in SIPU 2015 the share of firms who patented their most valuable innovation increased from 16% to 25% (see Arora et al., 2013). This is due to small changes in the composition of the sample which influences the overall observed propensity to patent – the share of firms in Professional, Scientific and Technical Activities, whose patent propensity is typically very high, was 11% in SIPU2013 but 18% in SIPU 2015.

In both the CIS9 and the SIPU2015 samples, product innovators, new-to-the-market innovators and continuous R&D performers are more likely to patent, although in SIPU the shares are somewhat lower, as is consistent with the de-scaling effect of focussing on a single innovation.[2] These findings are consistent with the studies by Arundel and Kabla (1998) and Hall et al (2013). For firms covered only by SIPU 2015, we are also able to distinguish among innovators who belong to a group and innovators whose innovations benefit from any form of external finance. We find that firms belonging to a group are more likely to patent their most valuable invention. Moreover, consistent with the work of Zobel et al (2016), we also find that external finance increases the probability that firms will patent their most relevant innovation.

The most remarkable finding in Table 3 is that the size effect vanishes - small and large firms are equally likely to patent their most relevant innovations. In column (2), which reports the shares observed in CIS, the share of small-firm innovators who applied for at least one patent is less than 20%, significantly different in statistical terms from the share of innovators who patent among medium firms (26.5%) and large firms (33%). In contrast, the shares in column (4) (which report the SIPU shares based on patenting of the most significant innovation) show that there are no large differences among firms of different size. Apart from the role of the scale of innovation, another explanation of these different results could be that, considering that patenting is a costly strategic decision taken by firms, financially constrained small firms will only apply for a patent when the value of their innovation is sufficiently high to justify that cost.

In Table 4 we examine these differences in a multivariate context controlling for several other factors such as the industry affiliation of the firm (proxied by 17 industry dummies)[3], its level of openness to external technology and the firm's reported levels of imitative competition. A detailed description of the variables constructed and their data source is contained in Appendix 2. We restrict our attention to SIPU innovators and estimate a probit model to explain the probability of patent application and the probability of trademark application, in order to protect the most valuable innovation. The results confirm all the descriptive findings of Table 3 with a one exception. We do not find a positive effect of introducing innovation that is new to the market. This can probably be explained by the presence of the R&D variable: since in most cases doing R&D is a necessary precondition to be able to develop patentable brand new products, once we control for it the positive effect of new to the market innovation

2 We also compared the probability to apply for a patent for different groups of firms in the two samples, to assess how this proportion varies. In the CIS9 survey around one quarter (25.2%) of the innovating firms applied for at least one patent. In the SIPU survey this share is higher, around 40%, showing that the innovators in SIPU are generally more likely to patent than the average UK firms.

3 The results are robust to the use of less fine-grained industry dummies (we also ran our models with only 7 macro-industry dummies), in order to avoid the risk of over-fitting of the model.

fades away. Even controlling for a range of other factors, size loses its effect in explaining patent behaviour.

Among the other control variables we also include some new variables not included in Table 3, but which have been suggested by the literature on patenting. We check for the effect of openness, i.e., the fact that a firm develops its most important innovation with other external partners, and we find that it exerts a negative effect on patenting. When we further investigate the effect of openness we find that it is not the degree of openness (the number of different types of external actors involved in the innovative process) that matters for the decision to patent or not, as for example argued by Laursen and Salter (2014). Rather, it seems that for some particular external partners, such as suppliers and clients, the negative effect is especially strong. This might suggest informal sharing of technology along the value chain or a clear delineation of paternity of technology using other more contractual forms (as argued by Miozzo et al 2016).

We also investigate a possible linkage between patenting and trademarking activity. In Table 4, the overall propensity to trademark for the firms' innovation portfolio (available from UK CIS 2015) is positive and significant suggesting that firms who generally trademark more are also more likely to patent their most important innovations. Our estimates suggest that between 1 in 6 or 1 in 7 trademark applicants will also go on to apply for a patent[4].

3.2. Using trademarks to protect markets

Unlike patents, trademarks do not require the company's product to be innovative or novel, although a number of recent studies suggest that innovators do use trademarks more often than others (Mendonca et al 2004; Jensen and Webster, 2009; Götsch and Hipp, 2012). Studies on the linkage between patents and trademarks suggest that trademarks may be used at an early stage of its life by a firm (Helmers and Rogers, 2011) and that such joint filings are preferred by radical innovators (Flikkema et al 2015).

Although patents and trademarks protect quite different characteristics of an innovation, they share the characteristic of exclusivity. The rationale for a trademark is believed to be information asymmetry between buyers and sellers (Landes and Posner 1987) and, as such, trademarks secure customer loyalty for some perceived qualities associated with the firm. However, if an R&D-performing firm was to produce a technology product that could be trademarked for its novel characteristics and/or distinctiveness, or if the technology product market was marked by information asymmetry between buyer and seller about the quality or reliability of the product, then we may expect firms to overcome this problem by using a trademark. Large firms with several products may have less to gain by adding an additional trademark, as their product may already be covered by existing trademarks. Trademarks are relatively cheap to obtain (compared with the costs of filing for a patent) and, in many cases, can cover a number of products. For both these reasons we should expect innovative small firms to apply for trademarks in larger numbers.

4 As an alternative way of measuring the same complementarity effect, we also estimated a bivariate probit where the probability to apply for a patent and for a trademark are the two dependent variables. The results of the estimation showed, first of all, that the coefficients of the independent variables do not change but, also, more importantly, the error terms of the two equations are positively and significantly correlated (r=0.53), suggesting a complementary effect between patenting and trademarking the firms' most valuable innovation.

In Table 3, earlier, we reported the main descriptive statistics on trademark application in CIS and SIPU. As with the discussion about patents, we use the CIS 2015 figures as a benchmark to understand the differences between considering the overall portfolio of firms' innovations with respect to their most relevant one. Table 3 shows that CIS 2015 innovators have a higher propensity to apply for trademark rather than for patents (29.5 versus 25.2%) and small firms

appear to be less likely to apply for a trademark when compared to large firms, although small innovators seem more likely to apply for a trademark than a patent (25.1% versus 19.6%). This may be down to costs – making a trademark application is very cheap compared to making a patent application. When we focus on the most relevant innovation indicated in SIPU, the share of innovations with a trademark application is slightly lower than for patents (22.7% versus 25.6%). As in the case of patents, when we use SIPU data to look at the size effect we find that size does not really matter: actually the share of large firms applying for trademarks is, in this case, even lower than the same share for small and medium firms because trademarks may be firm- rather than product-specific.

In Table 3 we also find that firms who introduce product innovations, firms who do new-to-market innovations and firms who perform R&D activities are more likely to apply for a trademark (in line with the findings for patents), both when we consider all CIS9 innovators and SIPU innovators. Conversely, belonging to a group or having access to external finance does not have any effect on the decision of whether to apply for a trademark.

Overall, this suggests that small firms have, in general, a higher propensity to apply for trademarks rather than for patents. Moreover, when we focus on firms' specific innovation we find that trademarks are less used than patents by all types of firms, suggesting that patent protection is more important when innovations are very valuable.

Table 4, columns 5-8, present the probit marginal effects for the factors associated with trademark propensity. In line with the findings of Table 3 we find that the coefficient of size is not statistically significant, while firms who introduce process innovation are less likely to apply for trademark with respect to product innovators. We do not find a statistically significant impact of R&D activities and new-to-market innovation, once we control for industry specific factors.

As with patents, we find that collaborating with external partners in the development of the most relevant innovation decreases the probability that firms will apply for trademarks. More specifically, in column (8), we find that it is mainly the collaboration with clients that decreases the willingness of firms to use trademarks. Part of the explanation for this is that firms that do more upstream work in a value chain are more likely to worry about technology than markets. It may also mean that the product produced by the supplier is a bespoke input to the client, who may have the branded product.

Table 4: Patent and trademark propensity

	Patent application			Trademarks application		
	(1)	(2)	(3)	(4)	(5)	(6)
Continuous R&D	0.090**	0.087*	0.090**	0.057	0.057	0.053
	(0.045)	(0.046)	(0.044)	(0.057)	(0.058)	(0.058)
Overall patent propensity				0.183**	0.191**	0.168*
				(0.084)	(0.086)	(0.086)
Overall trademark propensity	0.150**	0.156**	0.147**			
	(0.065)	(0.066)	(0.062)			
Value of invention	0.010	0.010	0.003	0.014	0.012	0.014
	(0.013)	(0.013)	(0.012)	(0.017)	(0.017)	(0.016)
Openness measures						
Openness (dummy)	-0.097**			-0.121**		
	(0.046)			(0.053)		
Level of openness		-0.080			0.108	
		(0.119)			(0.151)	
Suppliers			-0.13***			-0.053
			(0.034)			(0.054)
Clients			-0.068*			-0.18***
			(0.040)			(0.047)
Other types of collaborations			0.010			-0.076
			(0.058)			(0.063)
Small firm (<49 employees)	0.002	-0.016	-0.002	0.020	0.007	0.033
	(0.045)	(0.045)	(0.044)	(0.057)	(0.058)	(0.057)
Any external finance	0.228***	0.231***	0.202***	-0.003	-0.018	-0.011
	(0.076)	(0.075)	(0.073)	(0.063)	(0.063)	(0.065)
Reference product innovation						
Process innovation	-0.083**	-0.076*	-0.082**	-0.142***	-0.122**	-0.15***
	(0.040)	(0.043)	(0.038)	(0.051)	(0.056)	(0.049)
Business strategy	-0.137***	-0.141***	-0.14***	-0.076	-0.059	-0.095
	(0.034)	(0.036)	(0.032)	(0.068)	(0.074)	(0.061)
New to the market innovation	0.044	0.038	0.043	0.063	0.048	0.072
	(0.041)	(0.042)	(0.040)	(0.054)	(0.055)	(0.053)
Reference no competition						
Competitors 1 to 5	-0.041	-0.042	-0.035	-0.028	-0.030	-0.025
	(0.043)	(0.044)	(0.044)	(0.057)	(0.057)	(0.056)
Competitors more than 5	0.125	0.145	0.136	0.086	0.096	0.069
	(0.098)	(0.099)	(0.099)	(0.098)	(0.094)	(0.097)
17 industry dummies	yes	yes	yes	yes	yes	yes
Observations	277	277	277	277	277	277
Pseudo R-squared	0.233	0.220	0.252	0.142	0.127	0.157
Log-likelihood	-120.9	-123.0	-117.9	-127.4	-129.6	-125.2

Note: The coefficients reports the marginal effects from probit estimations. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

A more striking feature from Table 4 is the finding that innovators with larger patent portfolios are also more likely to apply for trademark protection for their most valuable innovation. The effect of patent portfolios on trademark propensity varies between 17-19% in our estimations – this is larger than the effect of trademark holdings on the propensity to apply for a patent, suggesting that just under 1 in 5 patentees also applies for a trademark, but this difference in coefficients is not statistically significant.

3.3. Use of informal protection strategies

Hall et al (2013) show that, in the UK, firms consistently rate lead time, confidentiality agreements and secrecy higher than patents as strategies to protect their innovations. In their seminal work on this subject, Cohen et al (2000) had found distinct clusters in their data, with strategic methods of IP being common in one cluster while patenting was common in the other. Since then, strategic methods (or non-formal methods) - as these alternative modes of appropriation are sometimes called (Hall et al 2013, Miozzo et al 2016) - have often been seen in academic and policy circles as applying to different kinds of firms. Thus, a popular conception of how innovation is transformed into value is that firms that can patent will do so and those that cannot will rely on lead time advantages and secrecy.

In a wide-ranging literature review on the use of formal and informal intellectual property protection methods, Hall et al (2014) also conclude that informal methods of protecting technology are more important in a variety of sectors than formal intellectual property protection. Their review, culled from a large number of empirical studies, reports that process innovators and new-to-market innovators tend to use secrecy and lead-time advantage more often than other types of innovating firms. The theoretical discussion of alternative modes of appropriation has tended to focus more on the trade-off (or complementarity) between patents and secrecy. Case histories of firms and industries have shown that formal and informal methods can be combined in different ways to extract the maximum value from innovations. Thus, Arora (1997) has shown that in the chemical industry it was typical to protect individual compounds of dyestuffs by patents, whereas the composition of the dyestuff itself was kept secret.

Much of our knowledge about the importance of alternative appropriation strategies comes from Innovation Surveys which ask whether firms use a particular value appropriation strategy and their self-reported assessment of its importance for protecting the rents from a firm's innovation. Very few studies have looked at actual use of these strategies to protect innovation rents. An exception is the study by Leiponen and Byma (2009) who surveyed small Finish companies and asked those firms questions about both the perceived importance of patents and secrecy and the actual use of patents and secrecy. Though only 15% of small firms rated secrecy as an important appropriation strategy, 62% of firms reported using secrecy to appropriate innovation rents.

Due to improvements to the UK CIS 2015 questionnaire, we can also shed light on the extent to which innovating firms in the UK used non–IP based strategies to protect their innovations. In this round of the CIS, respondents who reported having pursued innovative activities in the reference period were asked what proportion of their innovations were protected by the use of the following methods: using complex product designs, through the use of secrecy, by exploiting lead time advantage, through copyright registration and through design registrations. Some scholars, however, regard complex product design as a feature of the innovation itself rather than an active choice.

In Table 5 below we report the share of innovation that firms in CIS and SIPU reported as being protected by these alternative methods. We calculate the average over all innovations of firms - both those who reported using patents and those that did not. Table 5 reveals that patenting firms are more likely to protect a larger proportion of their innovations using (in rank order) secrecy, complexity, lead-time advantage, copyright and design registration. Non-patenting firms protect a smaller proportion of their innovations using complexity, secrecy, lead-time advantage, and copyright and design rights. Undoubtedly, this result is driven by the higher value of patentable innovations, as the proportions reported by SIPU respondents is always higher. The result is also related to the fact that patent monopolies can make it easier for firms to create lead time advantage that further protects the innovation or incentivises firms to create complex designs to deter reverse engineering. Similarly the desire to not disclose too much may predispose firms to using secrecy in combination with patenting.

The lower panel based on CIS data for the 277 innovators in the SIPU dataset shows a broadly similar ordering of the importance of different strategies but also that SIPU firms tended to use higher proportions of all protection methods, as we would expect for a higher value innovation.

Table 5: Share of innovations protected by alternative appropriation strategies

	Average proportion of innovations protected by				
	Complexity	Secrecy	Lead time advantage	Copyright	Design registration
CIS innovators (number)					
Innovating firms that also patented (666)	0.358	0.367	0.232	0.213	0.210
Innovating firms that did not patent (1987)	0.173	0.126	0.101	0.055	0.021
SIPU innovators (number)					
Innovating firms that also patented (71)	0.458	0.450	0.313	0.238	0.233
Innovating firms that did not patent (206)	0.312	0.216	0.201	0.115	0.066

In Table 6, below, we more closely examine the use of alternative modes of appropriation by non-patenting firms. Consistent with the previous literature we find that in the CIS data, small firms and product innovators protect a larger percentage of their innovations using lead time advantages. These differences vanish when we de-scale the data by focussing on the most valuable innovations of the firm.

Instead, the main finding from Table 6 is that new-to-market innovators and continuous R&D performers that do not patent are more likely to use (in rank order) complexity, secrecy and lead-time advantages to earn innovation rents. This result holds even when we control for industry dummies and reasons for not patenting (see Table 11 in Section 4.3). We also find that continuous R&D performers who do not patent are more likely to use copyrights to protect their innovations.

Table 6: Share of innovations protected by alternative appropriation strategies among non-patenting firm

	Average proportion of innovations protected by								
	Complexity		Secrecy		Lead time advantage		Copyright		Design registration
CIS innovators who did not patent (n=1987)									
Small firm (<49 employees)	0.180		0.130		**0.125**	**	**0.072**	**	0.026
Medium firm (50-249 employees)	0.169		0.128		0.094		0.047		0.018
Large Firms (> 250 employees)	0.164		0.117		0.065		0.036		0.020
Product innovation	0.214		0.153		**0.131**	*	0.064		0.027
Process innovation	0.174		0.129		0.100		0.050		0.020
New to Market	**0.287**	***	**0.211**	***	**0.173**	***	0.082		0.021
New to Firm	0.171		0.136		0.104		0.064		0.025
Continuous R&D	**0.257**	***	**0.207**	***	**0.147**	***	**0.078**	***	0.026
No R&D or discontinuous R&D	0.123		0.079		0.074		0.042		0.018
SIPU innovators who did not patent (N=206)									
Small firm (<49 employees)	0.365		0.231		0.245		0.116		0.042
Medium firm (50-249 employees)	0.274		0.183		0.164		0.112		0.073
Large Firms (> 250 employees)	0.218		0.237		0.152		0.120		0.127
Product innovation	0.367		0.250		0.225		0.112		0.076
Process innovation	0.227		0.165		0.188		0.113		0.036
New to Market	**0.393**	**	**0.261**	**	**0.225**	*	0.089		0.089
New to Firm	0.188		0.096		0.096		0.051		0.034
Continuous R&D	**0.402**	**	**0.327**	***	**0.265**	*	**0.192**	**	0.085
No R&D or discontinuous R&D	0.231		0.114		0.146		0.047		0.050

4. Reasons for not using formal protection methods: a multivariate analysis

Although the use of formal intellectual property in the form of patents and trademarks is easy to observe it is much harder to know why firms do not patent. A novel feature of SIPU 2015 was that it directly asked firms that had innovated - but did not patent or trademark - about the reasons for not doing so. This section reports our findings in this regard.

4.1. Barriers to patenting

A range of different reasons for not patenting were specified in SIPU and firms were allowed to tick more than one reason. The reasons for not patenting that respondents could choose included:

- innovation was not new to the market;
- the innovation was not eligible for patent protection;
- the cost of patent application was too high;
- a patent would have disclosed too much;
- infringement of the patent would be difficult to detect;
- by the patent would have been difficult to enforce.

In addition, there was a free form field where firms could enter other reasons not included on the list. We parsed the reasons given into existing categories and added a new category, that patenting was not considered relevant.

In Table 7, below, we report the frequency of each of the reasons for not patenting. The first column collects the responses of all firms that reported a valuable innovation, but did not patent that innovation. The three most important reasons for not patenting were: the innovation could not be patented (68%), by the patent would have been difficult to enforce (31%), and, lack of novelty (30%).[5] Interestingly, these three reasons continue to be the main reasons for not patenting even when we look across the different groups of firms. The fear that patents would disclose too much was the least frequently reported reason for not patenting (4%). Furthermore, open firms were more likely to say the innovation was not patentable rather than express worry about infringement or disclosure.

5 Lack of novelty can also result in an innovation being non-patentable, indeed in the following multivariate analyses we group the two reasons together.

Table 7: Reasons for not patenting given by innovating firms (% of firms choosing each reason)

Reasons for not patenting	Non-patenting firms (n=206)		Small firms	Medium Firms	Large firms	Product innovators	Process innovators	Not continuous R&D	Continuous R&D	Not Open	Open
The innovation was not eligible for patent protection	140	**67.9**	62.3	**76.1**	69.7	62.6	72.1	**75.4**	**58.7**	**75.7**	**63.6**
The patent would have been difficult to enforce	64	**31.1**	34.9	26.8	27.2	33.0	39.5	**25.4**	**38.1**	28.3	32.5
The innovation was not new to the market	62	**30**	33.0	28.4	24.2	**23.5**	**41.9**	**37.7**	**20.7**	31.1	29.5
The cost of patent application was too high	28	13.5	**20.8**	7.5	3.0	18.3	11.6	**7.9**	**20.7**	13.5	13.6
Infringement of the patent would be difficult to detect	21	10.2	11.3	9.0	9.1	12.2	9.3	9.6	10.9	12.2	9.1
A patent was not relevant	17	8.2	8.5	10.4	3.0	**9.6**	**0.0**	**12.3**	**3.3**	4.1	10.6
A patent would have disclosed too much	8	3.8	6.6	1.5	0.0	4.3	4.7	2.6	5.4	2.7	4.5
Other	4	1.9	0.9	3.0	3.3	2.6	0.0	0.8	3.3	1.4	2.3

Notes: Values in bold identify statistically significant differences.

Source: Computations from SIPU2015

The next three columns look at the reasons for not patenting by firm size. Statistically significant differences are highlighted in bold font. In general, the reasons for not patenting were similar between medium and large firms. Medium and large firms are more likely not to patent because their innovations cannot be protected by patents, especially when compared to small firms. Large firms often have in-house legal counsels and this may make them more aware of innovations that are unlikely to be patentable. One in five small firms (20%) reported not patenting because they found the cost of patenting to be too high (as compared to 7% of medium and 3% of large firms). This latter finding is consistent with the literature on small firms reviewed in Hughes and Mina (2013) who identify the cost of patenting to be the single largest obstacle to the use of patents by small firms. The SIPU survey shows that patenting costs can be an obstacle for small firms even when the innovation is extremely valuable for their business.

Looking across the other groups, firms whose main innovation was a process innovation were more likely to avoid patenting because of lack of novelty, suggesting that process innovation might not, necessarily, be associated with new-to-market innovations. Compared to process innovators, product innovators who did not patent were more likely to say patents were not relevant to their innovation. Distinguishing between firms who performed R&D continuously and firms who did not instead allows to distinguish a clear pattern: R&D performers are less likely to say that their innovations are not patentable, less likely to say that the innovation is not new to the market and less likely to claim that patenting was not relevant for their innovative strategy. On the contrary, R&D performers are more likely to say that the patent would have been difficult to enforce and that the cost of patent was high. Overall, the results suggest that R&D performers tend to work in technologies were patents are more relevant; also, they tend to introduce innovations that are really new, i.e., closer to the technological frontier. R&D performers are also more worried about the possible enforceability of the patent and this is likely to be related to them introducing truly brand new innovation that might be imitated by competitors.

We further investigate the reasons for not patenting through a multivariate analysis in which we include all the possible factors that might explain the decision of firms to avoid applying for a patent for their most valuable innovation. In order to obtain a more parsimonious specification we first classify all the possible types of reasons for not patenting in three main categories:

- *Non-patentable innovation:* which includes the following motivations: a) innovation was not eligible for patenting, b) patenting was not considered important by the firm, c) innovation was not new to the market.

- *Non-enforceable patent:* which includes: a) the patent would have been difficult to enforce b) infringement of the patent would have been hard to detect c) and patent would have disclosed too much.

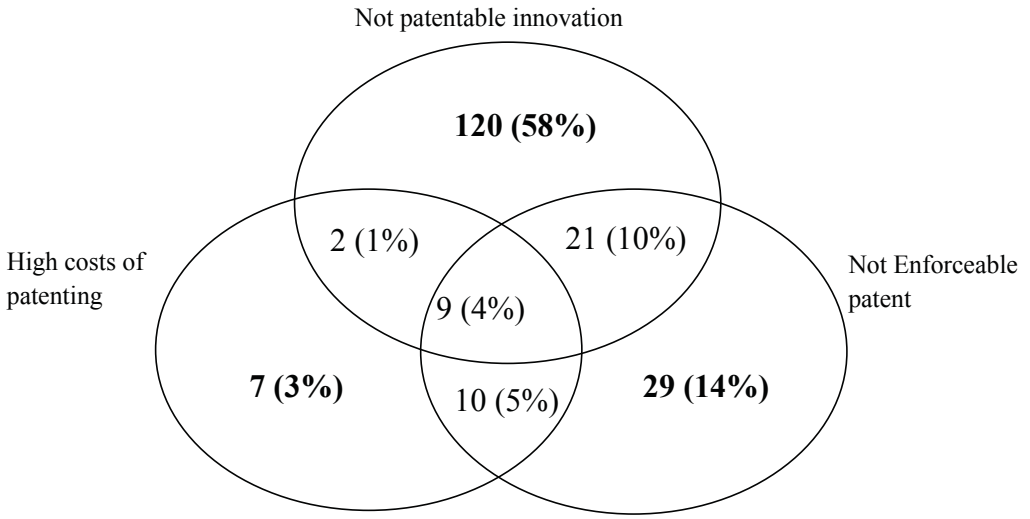
- *High cost of patenting:* for firms that reported that the cost of patent was too high.

In Figure (1) we use a Venn diagram to show the possible combinations of different motivations among the firms in SIPU 2015. On a total number of 206 firms that did not patent their most valuable innovation, 198 (82%) indicated one of the three motivations above as a reason for their decision.[6] Figure 1 shows that the most common reason for not patenting is due to the fact that the innovation is not patentable (approximately 73%; for 58% this was the only reason), followed by problems related to the fact that the patent was not enforceable or disclosed too much information (33%). Cost-related reasons are, instead, a relatively lower concern for SIPU firms, with only 13% of firms indicating it among the possible reasons and only 3% of the firms indicating it as the only reason. The graph also shows that a non-negligible number of firms (20%) indicated a combination of three (or two) rather than a single reason, suggesting that in some cases different factors matter at the same time.

6 The remaining eight firms either reported that the innovation was still not fully developed (and the patent application procedure had not been started yet), or did not report a specific reason.

In order to understand which factors drive each of the motivations for not patenting we restrict our analysis on the firms who innovated but did not apply for a patent and we run three separate probit models: for each we use as a dependent variable one of the three categories introduced above. The use of probit models is related to the binary nature of each of the three dependent variables, which are dummies (0/1).[7] The independent variables instead consist of all the other factors that we have introduced in the previous sections and that are likely to influence each of the motivations. In particular, these include the size of each firm, whether the firm performs R&D activities, the general propensity of a firm to patent its innovations, the specific value of the innovation, the type of innovation introduced (whether a product or process innovation, or a new business strategy), the novelty of the innovation (new-to-market or new only for the firm), the specific source of financing for the innovation and the type of collaborations put in place to develop it.[8]

Figure 1. Venn diagram of reason for not patenting.



Note: N= 206 (100%); in 8 cases (4%) none of the three reasons was specified as important (other reasons were specified as important).

7 Since we show that some of the reasons were jointly considered as important by some firms, we also checked whether the use of a trivariate probit model, which allows for the correlation between the error terms of each model, was more appropriate. The results showed that, indeed, there is some correlation between the error terms of the three models, in particular there is a positive and significant correlation between the error term of the non-enforceable patent model and the high cost of patenting specification. However, the signs and significance of the trivariate probit model are perfectly in line with those obtained running three separate probit analyses. Since in the case of the trivariate probit it is not straightforward to calculate marginal effects for each of the independent variables, we eventually decided to report marginal effects from the separate probit models, which are much easier to interpret.

8 In the regressions we only use 190 observations instead of 206, because some firms did not answer some of the questions in the survey that we used to build our independent variables (seven firms did not answer to the question related to financing sources, while another nine did not indicate the specific type of innovation). For this reason 16 observations could not be used in the empirical analyses.

In Table 8 we report the results of the estimation of the three separate probit models on each of the possible reasons for not patenting. Since we are reporting marginal effects and in most of the cases our regressors are dummy variables, we can interpret the coefficients in the table as the increase in probability when an independent variable changes from zero to one.

In column (1) we focus on the most common reason for not patenting, i.e. the non-patentability of an innovation. In line with the results of Table 7 the coefficient of R&D is negative and statistically significant at 10%, suggesting that R&D performers are less likely to consider their innovation as non-patentable. Innovators who introduce new-to-market innovations are less likely to say that the innovation was not patentable. The results also show that the specific type of innovation matters: innovators introducing new business strategies are 14% more likely to choose this reason with respect to product innovators. Other factors seem to matter much less: in general collaborating with an external partner slightly decreases the probability to indicate this as a reason for not patenting, but this relationship is never statistically significant. Lastly, the size of the firm, as well as the type of financing source chosen, does not play an important role.

Overall the results in column (1) suggest that innovating firms that perform R&D and introduce brand new innovations are less likely to say that their innovations are not patentable. The type of innovation matters too, since when innovations involve a new business strategy, they are generally unlikely to be patentable.

The results in column (2) focus on the correlates of non-enforceability of a patent as the main reason behind the decision not to patent. The only factor that really matters is the degree of novelty of the innovation: having an innovation that is truly new to the market increases by 22% the probability that a firm will indicate non-enforceability as an important motivation for not patenting. Also higher value innovations are associated with greater fears about non-enforceability of patents. Most of the other correlates related to the firm or to the innovation (type of innovation, source of financing, collaborations) are not statistically significant.

Table 8: Reasons for not patenting

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Not patentable		Not enforceable		High costs	
Continuous R&D	-0.140*	-0.133*	0.063	0.059	0.021	0.017
	(0.073)	(0.073)	(0.080)	(0.080)	(0.014)	(0.011)
Overall patent propensity	-0.283	-0.262	-0.055	-0.034	-0.028	-0.023
	(0.192)	(0.188)	(0.216)	(0.220)	(0.025)	(0.021)
Value of invention	-0.018	-0.022	0.043*	0.043*	0.001	0.001
	(0.021)	(0.020)	(0.023)	(0.023)	(0.002)	(0.001)
Reference product innovation						
Process innovation	-0.015	-0.007	0.101	0.101	-0.006	-0.005
	(0.089)	(0.086)	(0.104)	(0.104)	(0.004)	(0.004)
Business strategy	0.140*	0.145**	-0.162*	-0.143	-0.019**	-0.017**
	(0.072)	(0.073)	(0.093)	(0.096)	(0.009)	(0.008)
New to the market innovation	-0.121*	-0.132*	0.224***	0.218***	0.003	0.003
	(0.066)	(0.068)	(0.077)	(0.078)	(0.005)	(0.005)
Small firm (<49 employees)	-0.069	-0.075	0.090	0.095	0.022*	0.020*
	(0.068)	(0.067)	(0.083)	(0.083)	(0.013)	(0.012)
Any external finance	-0.013	-0.019	-0.062	-0.051	-0.011	-0.008
	(0.089)	(0.091)	(0.086)	(0.087)	(0.007)	(0.005)
Openness measures						
Openness (dummy)	-0.033		0.032		-0.002	
	(0.064)		(0.078)		(0.005)	
Suppliers		-0.080		0.043		0.003
		(0.087)		(0.098)		(0.006)
Clients		0.026		0.085		-0.004
		(0.082)		(0.106)		(0.004)
Other types of collaborations		-0.025		-0.074		-0.002
		(0.110)		(0.105)		(0.005)
17 industry dummies	YES	YES	YES	YES	YES	YES
Observations	197	197	197	197	197	197
Pseudo R-squared	0.224	0.229	0.176	0.181	0.356	0.368
Log-likelihood	-88.20	-87.61	-104.1	-103.4	-50.73	-49.73

The coefficients reports the marginal effects from probit estimations. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Not patenting thus emerges as a strategic decision for valuable and novel innovations that formal patenting cannot protect due to problems of enforceability. This is consistent with our data in Table 5, Section 3.3, where we found new-to-market innovators are also more likely to use complexity of design (to deter reverse engineering), secrecy and lead time advantage to protect their rents from innovation.

Finally, in column (3) we show the correlates of the probability that a firm indicates the high cost of patenting as a reason for not patenting its most valuable innovation.[9] As expected, small firms (less than 50 employees), which are usually financially constrained, are more likely to cite cost issues as a reason for not patenting. Costs are less important for firms introducing new business strategies: this is in line with the results of column (1), according to which the reason for not patenting business strategies is due to the impossibility to patent of this kind of non-technological knowledge. Firms who use an external or mixed (external and internal) source of finance (either public or private) for their innovations do not indicate costs as the factor preventing them from patenting; this can be explained by the fact that these firms probably solved their limited availability of internal financial resources precisely by resorting to external sources.

Summing up, the majority (82%) of firms did not patent their most valuable innovation because the innovation was not patentable. Non-patentability is less likely to be an obstacle for firms who undertake regular R&D and introduce new-to-market innovations. It is unclear what non-patentability means as it is a characteristic of the nature of the innovation and also the stringency of the legal system in establishing novelty. Policy can lower the bar for patentability in order to be more egalitarian but, as Bessen and Muerer (2009) have shown for the US, such a lowering of the bar for patentability is not without its own problems - in particular, it creates a costly litigious process for all innovators.

The second most common reason for not patenting (reported by 33% of firm) is due to the problems related to the enforceability of patents and the risk of disclosure. These problems are, however, likely to be specific to the context of the innovation and the fact that in some kinds of technologies imitation is easy. As these problems are particularly important for firms that are on the technological frontier and introduce truly novel innovations with a high economic value, policy intervention might target these specific firms to understand the reasons that make patents unenforceable.

Finally, a relatively low number of firms (13%) indicated the cost of patenting as an obstacle for the decision of whether to patent. Our results suggest that it is, especially, a problem for small firms with less than 50 employees who are usually more financially constrained. Moreover, this is a problem that does not affect firms who are able to finance their innovation through external or mixed sources of finance, such as venture capital or government funds, suggesting that the existence of alternative ways for financing innovation (with respect to internal resources), indeed, decreases cost-related obstacles for patenting. Novel policy interventions targeted at small firms which alleviate cost could improve patenting from this group.

9 Since costs reasons are indicated as a motivation for not patenting only by a small share of firms, in many cases some independent variables would perfectly predict the outcome variable. For example, for all firms collaborating with a Public Research Organization costs was not a reason for not patenting their own innovation. In these cases the probit estimator cannot use these observations, for lack of variability, and hence in column (3) of Table (5) three variables are omitted (PRO, Transport sector and Utilities and Primary sectors) and 16 observations could not be used in the analysis.

4.2. Reasons for not using trademark protection

In contrast to patents that are expensive to file and require novel technology, trademarks are cheap to apply for and so, in theory, everybody should try to benefit from the exclusivity provided by trademarks. As noted earlier, the theory of trademark use suggests that trademark use is more common when firms want to distinguish their product or service from the competition - such as when a new product line is developed or when firms are entering new markets where they are relatively unknown to consumers.

Conversely, trademarks would not be applied for when this threat does not exist; for example, when firms already possess trademarks or alternative channels for reaching the customer. Empirically, the reasons firms do not trademark is less well investigated. As in the case of patents, SIPU asked innovators for the reasons why they did not apply for a trademark for their most valuable innovation. The reasons for not using trademarks that respondents could choose included:

- The innovation was already protected by existing trademarks;
- There was no danger of infringement;
- The firm uses distribution channels to market our product;

In addition, there was a free form field where firms could enter other reasons not included on the list. We examined each of these additional reasons and reclassified them in the following three groups:

- Trademarks were not perceived as important by the firm
- Trademarks were not possible for the specific type of innovation
- The innovation was not novel enough to be eligible for trademark use

In Table 9 we present some data concerning the relevance of each of these different reasons and their frequency across different groups of firms. The most common reason for not applying for a trademark is the presence of a pre-existing trademark (27% of cases), followed by no danger of infringement (24%). Respectively 21% and 15% of the firms reported that trademarks were not important or that they were not possible for the specific innovation introduced. 11% percent of firms, instead, reported that they used distribution channels and, hence, did not need to trademark their innovations.

Overall, the results highlight the fact that, differently from patents, there is not a one-to-one correspondence between innovations and trademarks; firms might introduce new products and still use (extend) their old trademarks to also cover the new product. The second finding is that a number of innovators do not perceive trademarks to be a very effective way to protect their innovations, since they do not believe that there is significant danger of infringement, or they generally do not consider them as relevant tools for appropriating value

(such as when innovation involved bespoke work). As in the case of patents in some cases, then, the specific nature of the innovation did not allow for trademark application.

When we look at the impact of size on the different reasons indicated by firms who did not use trademarks, we find that small firms are generally more likely to say that trademarks were not important, while large firms are more likely to say that trademarks were not possible due

Table 9: Reasons for forgoing trademark protection given by innovating firms (% of firms choosing each reason)

Reasons for no trademark		No Trademark firms (n=203)	Small firms	Medium Firms	Large firms	Product innovators	Process innovators	No continuous R&D	Continuous R&D	Not Open	Open
Already existing trademark	55	27.1	29.2	25.4	23.3	25.2	25.5	28.4	25.5	25.7	27.8
No danger of infringement	49	24.1	20.8	28.4	26.7	24.3	31.9	**18.3**	**30.9**	28.6	21.8
Trademark not perceived important	44	21.7	**25.5**	17.9	16.7	20.0	21.3	25.7	17.0	**14.3**	**25.6**
Trademark not possible	32	15.8	11.3	17.9	**26.7**	19.1	10.6	14.7	17.0	**24.3**	**11.3**
Distribution channel to market product	24	11.8	12.3	13.4	6.7	13.9	6.4	11.0	12.8	**4.3**	**15.8**
Innovation without novelty	5	2.5	3.8	1.5	0.0	**0.9**	**6.4**	3.7	1.1	4.3	1.5
Other reasons	14	6.9	6.6	8.9	3.3	8.6	4.2	7.3	6.4	5.7	7.5

Source: SIPU2015. Notes: Values in bold identify statistically significant differences.

to the specific nature of the innovation. This suggests that while large firms are more aware of which kind of products can be protected by trademarks and which cannot, small firms tend to underestimate the value of trademark protection, possibly also because of lower awareness of how to use them.

We do not find very significant differences in the propensity to use trademarks among product and process innovators, although process innovators are more likely to indicate the lack of novelty as a reason for not using them (this is in line with the results found for patents, lack of novelty was a more frequent reason for not patenting among process rather than product innovators). Among firms that collaborate with external partners (open innovators) we find that they are more likely to consider trademarks as not important (due to the bespoke nature of the work) and because open firms reported use of other distribution channels to market their products.

In order to analyse the reasons for not trademarking within a regression framework, we reclassify the reasons provided by the firms for not trademarking their innovation into three main categories:

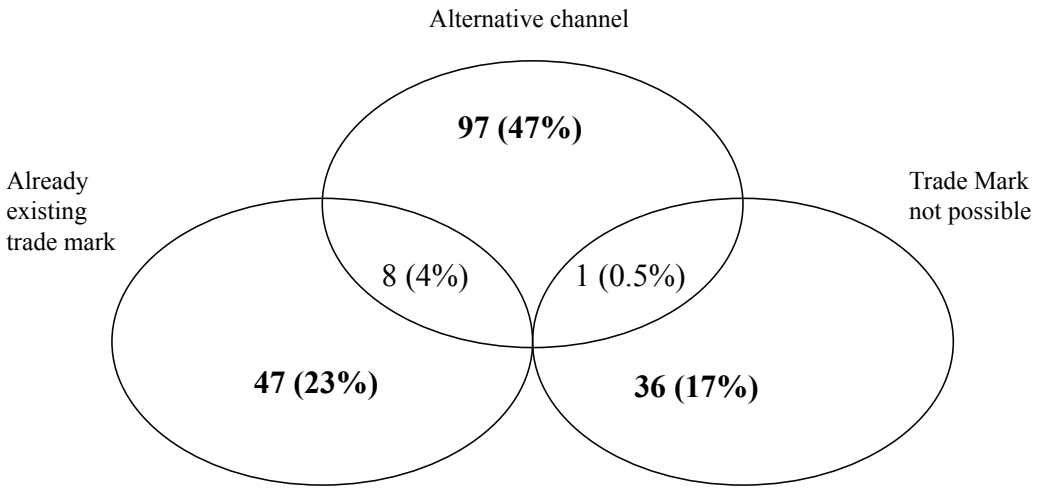
(i). Trademark not necessary and alternative channels, which includes the following reasons a) trademarks not considered important, b) no danger of infringement and c) use of alternative distribution channels

(ii). Trademark not possible, which includes the reasons a) trademark was not possible and b) non-novel innovation

(iii). Already existing trademarks: when the innovation was already covered by existing trademarks

In Figure 4 we show through a Venn diagram the distribution of these three main reasons and the overlapping of these reasons. The figure shows that by regrouping the reasons in such a way around half of the firms are classified in the category “trademark not necessary and alternative channels”, while the other two categories “already existing trademark” and “trademark not possible “ include 28% and 17% respectively of SIPU innovators (who did not use trademarks). The little overlap between these reasons suggests that they are not complementary reasons.

Figure 4: Venn diagram of reasons for not filing for trademark.



Note: N = 203 (100%); in 14 cases (7%) none of the three reasons was specified as important (other reasons were specified as important).

In Table 10 we report three probit estimates that explain the probability to indicate each of these reasons as relevant for the decision not to apply for a trademark for the most relevant innovation. Looking at the results, all of which control for industry specific factors, we find that few of the factors related to firm or innovation-specific features are able to explain the different reasons indicated by the respondents. Research and Development, and overall patent propensity are not significant, as well as the type of innovation (product, process or business strategy) and the degree of novelty of the innovation. Firms that obtained external financing were more likely to have an existing trademark.

In line with the results in Table 9 we find that adopting an open strategy for innovation increases the likelihood that trademarks were deemed not necessary or that alternative channels had been used, while at the same time collaboration on the most valuable innovation makes it less likely for the innovator to say that trademarks were considered not to be possible. When we disaggregate openness by type of collaboration we find that firms that collaborate with clients or others (consultants & public sector knowledge sources) are usually likely to say trademarks are not necessary or they have alternative sources of protection.

Table 10. Reasons for not filing trademarks

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**Not necessary and alternative channels**		**Trademark not possible**		**Existing trademark**	
Continuous R&D	0.048	0.056	-0.006	-0.006	0.010	0.007
	(0.086)	(0.086)	(0.024)	(0.024)	(0.074)	(0.074)
Overall patent propensity	0.068	0.086	-0.012	-0.014	-0.002	-0.003
	(0.151)	(0.153)	(0.039)	(0.039)	(0.129)	(0.132)
Value of invention	-0.004	-0.010	0.001	0.001	0.030	0.036*
	(0.024)	(0.024)	(0.006)	(0.006)	(0.021)	(0.021)
Openness measures						
Openness (dummy)	0.152*		-0.065*		0.028	
	(0.079)		(0.034)		(0.067)	
Suppliers		0.057		-0.036*		0.123
		(0.099)		(0.019)		(0.092)
Clients		0.208**		-0.039**		-0.103
		(0.096)		(0.020)		(0.079)
Other types of collaborations		0.219**		-0.046***		0.057
		(0.110)		(0.017)		(0.111)
Small firm (<49 employees)	0.065	0.058	-0.025	-0.023	-0.020	-0.013
	(0.090)	(0.091)	(0.025)	(0.026)	(0.079)	(0.079)
Any external finance	-0.171*	-0.178*	0.003	0.004	0.249***	0.240**
	(0.096)	(0.097)	(0.027)	(0.028)	(0.096)	(0.094)
Reference product innovation						
Process innovation	0.040	0.057	-0.009	-0.011	-0.011	-0.024
	(0.098)	(0.098)	(0.023)	(0.022)	(0.082)	(0.079)
Business strategy	0.002	0.012	-0.027	-0.027	0.102	0.065
	(0.113)	(0.115)	(0.020)	(0.020)	(0.104)	(0.102)
New to the market innovation	-0.095	-0.109	0.014	0.014	-0.069	-0.048
	(0.080)	(0.080)	(0.022)	(0.022)	(0.067)	(0.066)
17 industry dummies	YES	YES	YES	YES	YES	YES
Observations	196	196	198	198	196	196
Pseudo R-squared	0.0588	0.0685	0.168	0.173	0.0810	0.103
Log-likelihood	-127.7	-126.4	-80.51	-80.08	-106.0	-103.5

The coefficients reports the marginal effects from probit estimations. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

4.3. Factors associated with the use of informal protection methods

Section 3.3 has already noted that the use of patents was complementary to the use of other informal methods of appropriating value. The literature on the use of formal and informal intellectual property has, however, identified several ways in which other appropriation methods can overcome particular challenges faced by firms that wish to protect their innovations, but cannot use patenting. Since firms in SIPU that did not patent also tended not to use patents at all (Table 2), in this last section of this report we investigate if the barriers to patent use are systematically correlated to the use of alternative methods.

There is extensive theoretical literature (reviewed in Hall et al 2014) examining the patent-secrecy trade-off in the context of a single invention. The choice is explained by the inherent trade-off between the benefits from using patents and its costs, relative to relying on secrecy. Benefits and costs are not only a function of the invention that qualifies for patent protection, but also of defensive or offensive strategic considerations taking into account a firm's competitors' behaviour. These theoretical models focus on the innovation rents that each appropriability mechanism generates and suggest that firms will choose the strategy that allows maximisation of the extracted innovation rents. In turn, the size of the innovation rents is affected by the novelty of innovation and the degree of imitative competition although the direction of the two effects is unclear.

In a seminal paper, Anton and Yao (2004) show that imitative competition can eat into innovation rents, while novelty of the innovation may have the opposite effect on the innovation rents. In this model, the size of the innovative step becomes the key variable that decides whether a firm will choose patents against secrecy. Indeed, if the innovative step is not very large, the innovation rents from the actual innovation will not be too large and need to be supplemented by other sources of revenues (like licence income and royalties); in this case patenting may be preferred. However, if the innovative step is large, secrecy will be preferred as the innovation rents will be very large. In other words a large novel step may render patenting unnecessary as the firm can just as easily exploit the first to market advantages. The implication of this model is that, when an innovation is very novel, patenting may be unnecessary but smaller value inventions may be patented as they may not be easy to protect otherwise.

Along similar lines, Heger and Zaby (2013) offer an explanation for the empirically observed variation in patent propensities across companies. The authors show theoretically that the decision to patent depends on the effect of competition associated with the disclosure of information required by a patent. This effect varies across firms because it depends on the competitive advantage of companies. This variation in the cost of disclosure due to a patent translates directly into variation in patent propensities across firms.

When we expand the set of informal IP methods to include lead time advantages and complex design, theory suggests that a similar set of variables can explain the choice. While lead time advantage allows firms first mover advantage, another option for firms that fear imitation is to make product designs more complex in order to deter reverse engineering or if

they fear patents may disclose too much. Henry and Ruiz-Aliseda (2012) argue that if imitation is fairly costly, competitors may wait for a simpler model to reverse engineer in order to imitate and thus the firm could give themselves a lead time advantage before imitation shrinks the profits to a particular invention.

Factors that normally deter patenting (poor patentability, fear of disclosure or fears about enforceability of the patent) may naturally lead firms towards informal methods of protecting their IP. However, the effect of these factors may be exacerbated or dissipated by the strength of imitative competition and the relative novelty of the innovation. When the technological lead is large (as in the case of new-to-market innovations) and the imitative competition is low, firms will prefer to use lead time and secrecy in order to earn rents to their innovation. The scope for using lead time or complex design to generate more profits is also likely to be preferred in industries with large sunk costs (e.g., marketing-intensive industries) or those with large economies of scale.

In Table 11, below, we analyse the correlates of a lower or higher share of innovations under the three alternative methods of value appropriation using informal IP, in other words. lead time advantage, complex design and secrecy. We separate the reasons for not patenting into a number of categories (described earlier) and include some basic firm attributes as well as industry dummies - the coefficients in this table should be interpreted as conditional means. We find that among the reasons for not patenting, fear of disclosure drives firms to embrace informal IP methods. This is an interesting result as it confirms the role that disclosure plays in deterring firms from using patents.

Table 11: Reasons for not patenting as determinants of the use of informal IP

	Share of innovations protected by		
	Product complexity	Trade secrecy	Lead time advantage
Reasons for not patenting			
Innovation was not novel	-0.072	-0.183***	-0.061
	(0.062)	(0.055)	(0.054)
Patenting was not possible	-0.028	-0.018	-0.006
	(0.073)	(0.075)	(0.069)
Patenting cost was too high	-0.074	-0.029	-0.067
	(0.077)	(0.084)	(0.072)
Patent would have disclosed too much	0.248*	0.273**	0.336**
	(0.144)	(0.112)	(0.143)
Fear of infringement	-0.091	-0.168**	-0.036
	(0.095)	(0.075)	(0.105)
Patent would be difficult to enforce	-0.037	-0.021	0.005
	(0.078)	(0.064)	(0.074)
Firm attributes			
Firm undertakes continuous R&D	0.078	0.106*	0.023
	(0.062)	(0.060)	(0.058)
Small firm (<50 employees)	0.164**	-0.029	0.071
	(0.083)	(0.078)	(0.063)
Medium firm (50-200 employees)	0.112	-0.063	0.020
	(0.080)	(0.081)	(0.058)
Product innovator in CIS	0.102	0.084	0.097
	(0.069)	(0.067)	(0.065)
Process Innovator in CIS	0.053	0.027	0.055
	(0.063)	(0.057)	(0.056)
Share of new to market innovations in revenues from innovation	0.161**	0.032	0.148**
	(0.074)	(0.068)	(0.071)
17 sector dummies	Included	Included	Included
Constant	0.023	0.198*	0.026
	(0.104)	(0.106)	(0.096)
Observations	169	166	162
R-squared	0.282	0.315	0.290
df_m	26	26	26
df_r	142	139	135
F	4.226	4.076	3.099

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

However, firms that do not have novel innovations or firms that fear infringement show a smaller share of innovations protected by trade secrecy. Firms with a larger share of new-to-market innovations tend to protect their innovations by using complex design (to deter reverse engineering) and by exploiting lead time advantages. Small firms are also more likely to invest in complex design to protect their innovative rents.

We also investigated the impact of including competition and novelty of the innovation and whether they moderate the reasons for not patenting and lead to a preference for the use of informal IP to protect innovative rents. We investigated whether the impact of the fear of disclosure on the propensity to use trade secrecy is mediated by the novelty of the innovation. A positive result would confirm the theoretical notion that secrecy may be preferred if the innovative step is large. In both cases (inclusion of competition and novelty), the addition of these new variables was rejected by F-tests for their inclusion although the sign on these coefficients was as we expected.

Industry dummies, however, retained a strong explanatory power - consistent with much of the empirical literature on the choice of modes for protecting innovations. Industry dummies reflect the business environment and competition that faces the firm as it tries to realise value from its innovation petition. Table 12, below, outlines the shares of innovation protected by formal and informal IP in the UK CIS, averaged by broad industrial sectors. We have picked out the sectors where the majority of the SIPU observations originate.

We see the dominance of chemicals, electronics, machinery and equipment, and transport machinery in patenting activities, and this is consistent with the empirical literature on patenting. We also see a large role for complex design in those industries which are more likely to make bespoke products such as machinery, woodworking, or those that use several components such as computing equipment, and ICT. The services sectors also show the importance of secrecy and non-disclosure agreements. Sectors that show high shares of secrecy do not show high shares of patenting, as discussed in Hall et al (.2014)

Table 12: Distribution of shares among industrial sectors

Industrial Sectors	Proportion of innovations protected by			
	Patents	Lead time advantage	Complex design	Secrecy
Food and Textiles	0.22 (0.44)	0.3 (0.48)	0.5 (0.53)	0.44 (0.53)
Wood and Paper	0 (0)	0.5 (0.58)	0.5 (0.58)	0.5 (0.58)
Other manufacturing	0.70 (0.48)	0.50 (0.53)	0.73 (0.47)	0.78 (0.44)
Chemicals and rubber	0.50 (0.52)	0.33 (0.5)	0.64 (0.50)	0.55 (0.52)
Metal and non-metal products	0.33 (0.49)	0.5 (0.51)	0.61 (0.50)	0.44 (0.51)
Computer electronics and electrical equipment	0.27 (0.47)	0.82 (0.40)	0.73 (0.47)	0.73 (0.47)
Machinery and equipment (and repairs of)	0.40 (.51)	0.62 (.51)	0.79 (0.43)	0.69 (0.48)
Motor vehicles and other transport vehicles	0.40 (0.52)	0.60 (0.52)	0.60 (0.52)	0.60 (0.52)
Construction	0.12 (0.33)	0.24 (0.44)	0.35 (0.49)	0.18 (0.39)
Wholesale and retail trade	0.20 (0.40)	0.30 (0.46)	0.35 (0.48)	0.24 (0.43)
Transportation and storage	0 (0)	0.07 (0.27)	0.21 (0.43)	0.29 (0.47)
Accommodation and food services	0.05 (0.22)	0.10 (0.30)	0.19 (0.40)	0.10 (0.30)
Information and communication	0.13 (0.34)	0.38 (0.49)	0.45 (0.51)	0.48 (0.51)
Financial and insurance activities	0.20 (0.41)	0.36 (0.50)	0.36 (0.50)	0.50 (0.52)
Professional, Scientific and technical activities	0.25 (0.44)	0.38 (0.49)	0.58 (0.50)	0.45 (0.50)
Administrative and support services	0.10 (0.31)	0.15 (0.36)	0.31 (0.47)	0.18 (0.39)
Others	0.12 (0.32)	0.16 (0.37)	0.24 (0.43)	0.19 (0.39)

8. Summary and some implications

This report takes advantage of a brand new survey on the use of patents and trademarks to protect their most valuable innovation by innovating firms in the UK – the SIPU– to understand the reasons why some firms do not use patents and trademarks for the protection of their (valuable) innovations. The main advantage of the SIPU is that it has a rich number of variables that allow the identification of the nature of innovations introduced by firms and, most importantly, it allows the gathering of information about firms' most valuable innovations, instead of focusing on the overall innovation portfolio. This means that we can analyse data about economically valuable innovations, i.e., innovation that directly contributes to fostering the competitive advantage of firms, differently from existing studies that often cannot identify the value of different innovations introduced by firms and, instead, use indirect patent-related proxies, such as patent citations, litigations or renewals. In this section we address the question of what our results mean for patent and trademark policy and our understanding of how these instruments for protecting innovation are used by firms.

Our first finding, which should be of interest to policy, is that small firms are just as motivated as large firms to protect their innovations with patents when they can. The fact that small firms patent less than large firms simply reveals that they have fewer innovations to patent. Once we focus on economically valuable innovations we do not find any significant difference in the propensity to patent between small and large firms. We find, instead, that among the innovators who did not patent, the cost of patenting is considered as an important barrier to patent only by small firms, signalling that the costs relating to the patenting process are the main barrier to small firm use of patents and trademarks. However, it is important to stress that these costs often involve more than the application costs (which are usually quite low), but may reflect other costs related, for example, to patent litigation and other legal issues. Recent initiatives like the pro bono provision of litigation advice by the Chartered Institute of Patent Attorneys seems to be a step in the right direction and more should be done to bring these costs of enforcement down for small firms.

The second finding concerns the reasons for not patenting. Many firms indicated that their (most valuable) innovation was simply "not patentable" or that they believed that enforcement was difficult should also give pause for thought. The non-patentability of the innovation raises the question of the requirements for patenting: while in some cases it might simply be that the innovation mentioned is not a technological one (it could be a service or marketing innovation), so it does not fall within the range of what is legally patentable, it could also be that in some cases the overall requirements needed to obtain a patent (novelty) might discourage firms from applying for a patent. It seems important from a policy perspective to point out that an important reason for not patenting is due to the technical requirements needed to have a patentable innovation, rather than to the risk of disclosing knowledge to competitors. If policy action is to be taken in order to increase the overall propensity to patent of firms, a thorough analysis the factors that make patenting "not possible" for some innovations would be extremely useful. That the lack of enforcement is seen as an important barrier to the patenting of new-to-market innovations is also interesting as it suggests that policy attention might be directed to understand the reasons related to the perceived inability of firms to protect their own technology through patents.

Our findings concerning the complementarity between patents and trademarks and their use as joint proxies of innovation suggest that the positive correlation between these two formal IP measures should be interpreted with some caution. First of all, we find that while patenting activity often also increases the probability to trademark, the opposite is also true, suggesting some complementarity between the use of patents and trademarks. However, we also find that the reasons behind the decision not to patent an innovation are very different from the reasons given for not applying for a trademark. One of the most important differences is that a firm that has an existing trademark is the most likely to not apply for a new one, even if the innovation is the most valuable for the company. Hence trademarks, differently from patents, do not display a one-to-one relationship with innovations. This important difference should be taken into account in future applied works that make use of trademarks and patents as proxies for innovation.

We also find two results that might be of interest to managers of intellectual property. We highlight them, here, as it is beyond the scope of this report to address these issues more fully.

First, while openness and collaborative innovation has been shown in many studies to be inversely related to patenting and other formal IP such as trademarks, we find that this is the case only when we look at collaborative innovation with suppliers and clients. The reasons for not patenting among open firms do not reveal any of the anxieties that are often assumed, in other words, fear of leakage/disclosure to collaborators. However, open firms engage in collaborative innovation when their markets are protected by pre-existing trademarks. The fact that we see these patterns only with suppliers and clients suggests a deeper strategic concern with control over technology and markets that probably goes hand in hand with collaborative innovation. Second, our results concerning the largely complementary relationship between formal and informal IP are also interesting and contrary to the assumption that informal IP somehow constitutes an alternative to formal IP use. Instead, our findings highlight the importance of recognising that most innovative firms work with a portfolio of innovations rather than a single innovation. However, the data need to be probed more in order to understand the sources of this complementarity.

9. References

Anton, J., and Yao, D. A. (2004) Little Patents and Big Secrets: Managing Intellectual Property, *RAND Journal of Economics 35*, (1), 1–22.

Arora, A. (1997) Patents, Licensing and Market Structure in the Chemical Industry. *Research Policy, Vol. 26* (4–5): 391–403

Arora, A., Athreye, S. and Huang, C. (2013) Innovation, Patenting and Licensing in the UK: Evidence from the SIPU survey, *UK IPO Working Paper Series,* 2013/25.

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

Bessen, J. and Meurer, M.J. (2009) *Patent Failure. How Judges, Bureaucrats, and Lawyers Put Innovators at Risk*, Princeton University Press.

Cohen, W. M., Nelson, R.R. and Walsh, J.P., (2000) Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not). *NBER Working Paper*, No. 7552.

Flikkema, M.J., Castaldi, C., de Man, A.P. and Seip, M. (2015) Explaining the Trademark-Innovation Linkage: the Role of Patents and Trademark Filing Strategies, *Academy of Management Proceedings*.

Götsch, M. and Hipp, C. (2012). Measurement of innovation activities in the knowledge intensive services industry: a trademark approach. *The Service Industries Journal*, 32(13), pp. 2167-2184.

Hall, B.H., Helmers, C., Rogers, M. and Sena, V. (2013), The importance (or not) of patents to UK firms, *Oxford Economic Papers*, 65 (3): 603-629.

Hall, B.H., Helmers, C., Rogers, M., Sena, V. (2014) The Choice between Formal and Informal Intellectual Property: A Review. *Journal of Economic Literature*, 52 (2), pp. 375-423.

Heger, D. and Zaby, A. (2013) The heterogeneous costs of disclosure and the propensity to patent, *Oxford Economic Papers*, 65

Helmers, C. and Rogers, M., (2011) Does patenting help high-tech start-ups?, *Research Policy*, 40(7), 1016-1027

Henry, E. and Ruiz-Aliseda, F. (2012) Innovation Beyond Patents: Technological Complexity as a Protection against Imitation, *CEPR Discussion Papers 8870*

Jensen, P. H. and Webster, E. (2009). Another look at the relationship between innovation proxies. *Australian Economic Papers*, 48(3), pp. 252-269.

Landes, W. and Posner, R., (1987) Trademark Law: An Economic Perspective, ***Journal of Law and Economics***, 30, 2, 265-309

Laursen, K. and Salter, A. J.. 2014. The paradox of openness: Appropriability, external search and collaboration. ***Research Policy*** 43 (5): 867-878.

Leiponen, A., and Byma, J. (2009). If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies, ***Research Policy***, 38 (9), 1478-1488

Mansfield, E. (1986), Patents and innovation: An empirical study, ***Management Science***, 32, 173-181.

Mendonça S., Pereira, T.S. and Godinho, M.M. (2004). Trademarks as an indicator of innovation and industrial change. ***Research Policy***, 33, 1385-1404

Miozzo, M., Desyllas, P., Lee, H., and Miles, I. (2016). Innovation collaboration and appropriability by knowledge-intensive business services firms. ***Research Policy***, 45 (7), 1337-1351

Neuhaeusler, P. (2009) Formal vs. informal protection instruments and the strategic use of patents in an Expected-Utility framework, Fraunhofer ISI discussion papers innovation systems and policy analysis, No. 20, http://nbn-resolving.de/urn:nbn:de:0011-n-1021723

Scherer, F.M. and Harhoff, D. (2000) Technology policy for a world of skew-distributed outcomes, ***Research Policy***, 29, (4–5), 559–566

Scotchmer, S. and Green, J. (1990) Novelty and disclosure in patent law, ***RAND Journal of Economics***, 21, 131–146.

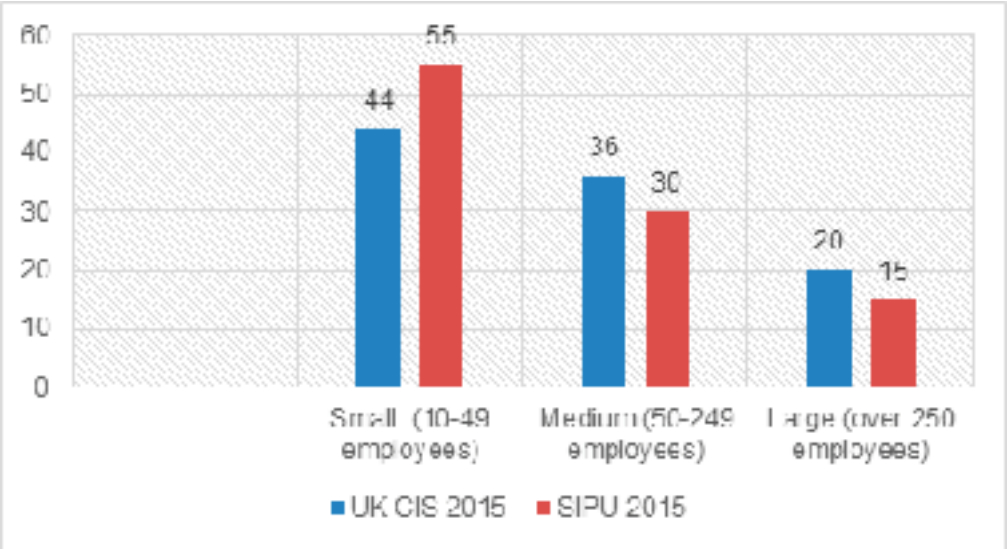
Zobel, A.-K., Balsmeier, B., Chesbrough, H. 2016. Does Patenting Enable or Inhibit Open Innovation? ***Industrial and Corporate Change***, Volume 25, Issue 2,307-331.

Appendix 1: Comparing the SIPU 2015 and CIS 2015 samples

As noted in the Introduction to the report, the main advantage of the SIPU sampling frame was access to information in CIS 2015 which helped to understand the broader technological behaviours of firms. SIPU sampled all firms who had agreed to respond to questions about their most valuable innovation from the 15,091 firms that were surveyed by UK CIS 2015. This provided a total eligible sample of 886 businesses. 477 (54%) of these businesses had specifically indicated on the UKCIS 2014 that they had engaged in product, process or business strategy forms of innovation activity in the period 1 January 2012 to 31 December 2014. The survey achieved a response rate of 72% with 277 innovators and 291 non-innovators.[10] Here, we compare the sample achieved by SIPU to that of CIS in three dimensions.

First, we examine size. As Figure A1 below shows, SIPU over-sampled the small firms but under-sampled medium and large firms in comparison to the UK CIS.

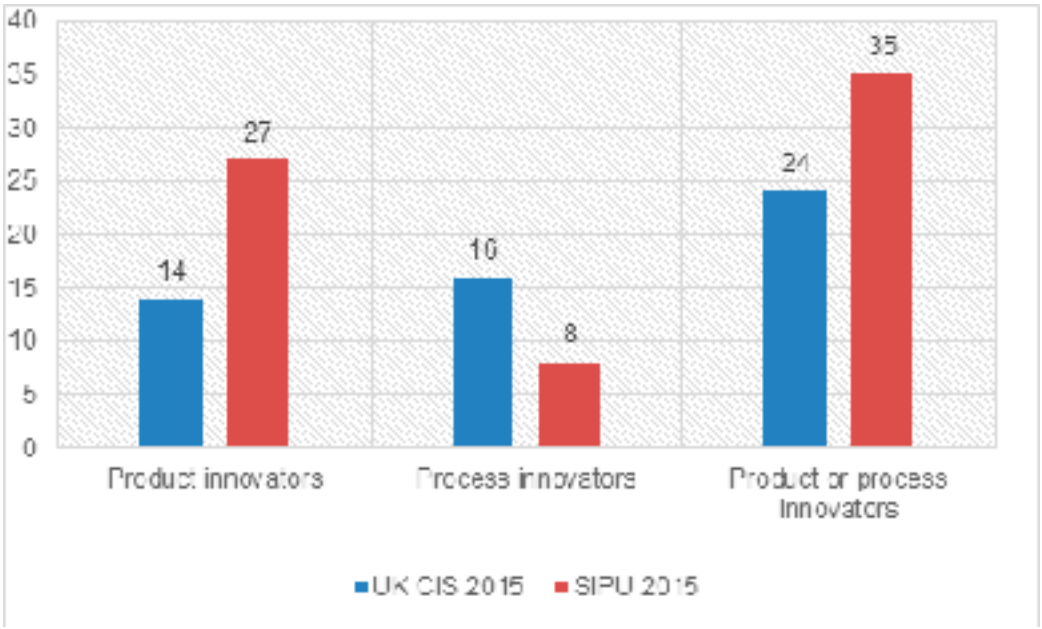
Figure A1: Size distribution of firms in the SIPU 2015 sample compared to CIS 2015



10 The other 66 firms included in the SIPU survey did not provide information about their innovation activities

Second, we look at the proportion of innovators in the three samples. As Figure 2 below shows, SIPU over-sampled innovative firms overall, but also oversampled product innovators vis-à-vis the CIS.

Figure 2: Distribution of innovators in SIPU and CIS



Lastly, we compare the industry composition of SIPU 2015 with CIS 2015 by broad sectors of industry. Table A1 which looks at the industry coverage of the two surveys shows that SIPU over-sampled manufacturing of all types in comparison to CIS 2015 but it under-sampled construction hotels and restaurants and all types of services, generally, including professional services. To the extent that manufacturing firms are more likely to use patents and trademarks - this may influence our results.

Table A1: Sample coverage by broad industrial classification

Industry sector (based on SIC 2007)	CIS	% of sample	SIPU	% of sample
Div 05-09: Mining and Quarrying	137	0.91	3	0.47
Div 10-18: Mfr of food, clothing, wood etc	682	4.52	22	3.47
Div 19-25: Mfr of fuels, chemicals, plastics	755	5.00	40	6.31
Div 26-28: Mfr of electrical & optical equips	478	3.17	25	3.94
Div 29-30: Mfr of transport equipments	262	1.74	10	1.58
Div 31-33: Mfr not elsewhere classified	280	1.86	19	3.00
Div 35-39: Electricity, gas & water supply	232	1.54	8	1.26
Div 41-43: Construction	740	4.90	23	3.63
Div 45-46: Wholesale trade (incl cars & bikes)	4,214	27.92	163	25.71
Group 47: Retail Trade (excl cars & bikes)	460	3.05	13	2.05
Div 49-52: Transport	592	3.92	20	3.15
Group 53: Post and courier activities	120	0.80	4	0.63
Div 55-56: Hotels & restaurants	684	4.53	28	4.42
Div 58,62&63: Computer and related activities	449	2.98	26	4.10
Div 59-60: Motion picture, video and tv progs	126	0.83	11	1.74
Group 61: Telecommunications	166	1.10	9	1.42
Div 64-66: Financial intermediation	668	4.43	22	3.47
Group 68: Real estate activities	361	2.39	8	1.26
Groups 69,70,75,76,78-83: Other services nec	2,208	14.63	102	16.09
Group 71.1: Architectural & engineering activities etc	421	2.79		0.00
Group 71.2: Clinical testing and analysis	113	0.75	25	3.94
Group 72: Research and experimental devpt	399	2.64	37	5.84
Group 73: Advertising and market research	186	1.23	4	0.63
Group 74: Other professional, scientific etc	146	0.97	6	0.95
Group 77: Renting of machinery, equip etc	212	1.40	6	0.95

Appendix 2: Description of variables used in the tables 1 - 11 of the report

Table A2: Description of dependent variables used in the analysis

Variable	Source of Data	Description of the variable
Patent application (Table 6)	SIPU 2015	Dummy variable =1 when respondent reports applying for a patent to protect their most valuable innovation
Trademark application (Table 6)	SIPU 2015	Dummy variable =1 when respondent reports applying for a trademark to protect their most valuable innovation
Non-patentable innovation(Table 8)	SIPU 2015	Dummy variable=1, if firm said any of the following reasons prevented them from applying for a patent- a) innovation was not eligible for patenting, b) patenting was not considered important by the firm, c) innovation was not new to the market.
Non-enforceable patent (Table 8)	SIPU 2015	Dummy variable=1, if firm said any of the following reasons prevented them from applying for a patent-a) the patent would have been difficult to enforce b) infringement of the patent would have been hard to detect c) and patent would have disclosed too much
High cost of patenting (Table 8)	SIPU 2015	Dummy variable=1, if firm said high costs prevented them from applying for a patent
Trademark not necessary (Table 10)	SIPU 2015	Dummy variable=1, if firm said any of the following reasons prevented them from applying for a trademark- a) trademarks not considered important, b) no danger of infringement and c) use of alternative distribution channels
Trademark not possible (Table 10	SIPU 2015	Dummy variable=1, if firm said any of the following reasons prevented them from applying for a trademark- a) trademark was not possible and b) non-novel innovation
Existing trademarks (Table 10)	SIPU 2015	Dummy variable=1, if firm said its reason for not seeking a trademark was because the innovation was already covered by existing trademarks
Share lead time advantage	CIS 2015	The proportion of innovations between 2012-2014 that was protected by lead time advantages
Share complex product design	CIS 2015	The proportion of innovations between 2012-2014 that was protected by complex product designs
Share secrecy	CIS 2015	The proportion of innovations between 2012-2014 that was protected by secrecy(and non-disclose agreements)

Table A3: Description of associated variables used in the analysis

Variable	Source of Data	Description of the variable
Firm specific variables		
Small firm	CIS 2015	Dummy variable =1, if the firm employed less than 50 persons
Medium firm	CIS 2015	Dummy variable =1, if the firm employed between 50 and 249 employees
Large firm	CIS 2015	Dummy variable =1, if the firm employed more than 250 employees
Continuous R&D	CIS 2015	Dummy variable that takes value 1 if firms had undertaken internal R&D in 2012, 2013 & 2014
Overall patent propensity	CIS 2015	The proportion of innovations between 2012-2014 that was protected by patents
Overall trademark propensity	CIS 2015	The proportion of innovations between 2012-2014 that was protected by trademarks
17 Industrial sectors	CIS 2015	Based on the 2-digit SIC and aggregated to get a minimum of 20 observations per group. See Table A1 for details
Innovation specific variables (for the commercially most valuable innovation)		
Openness	SIPU 2015	Dummy variable =1 when respondent reports collaborative partner was involved in producing its most valuable innovation
Suppliers	SIPU 2015	Dummy variable =1 when respondent reports collaboration with supplier was involved in producing its most valuable innovation
Clients	SIPU 2015	Dummy variable =1 when respondent reports collaboration with client was involved in producing its most valuable innovation
Other types of collaboration	SIPU 2015	Dummy variable =1 when respondent reports collaboration with public sector labs, consultants, competitors or HEI was involved in producing its most valuable innovation
Value of innovation	SIPU 2015	Value of turnover (%) in 2014 accounted for by the most valuable innovation
Product innovation	SIPU 2015	Dummy variable =1, if the most valuable innovation was a product innovation
Process innovation	SIPU 2015	Dummy variable =1, if the most valuable innovation was a process innovation
Business strategy innovation	SIPU 2015	Dummy variable =1, if the most valuable innovation was a wider innovation
New to the market innovation	SIPU 2015	Dummy variable =1, if the most valuable innovation was a new to the market
New to the firm innovation	SIPU 2015	Dummy variable =1, if the most valuable innovation was new to the firm
Any external finance		Dummy variable =1, if the firm used any external finance to finance its most valuable innovation

Concept House
Cardiff Road
Newport
NP10 8QQ

Tel: 0300 300 2000
Fax: 01633 817 777
Email: information@ipo.gov.uk
Web: www.gov.uk/ipo

Facebook: TheIPO.UK
Twitter: @The_IPO
YouTube: ipogovuk
LinkedIn: uk-ipo

For copies in alternative formats please contact our Information Centre.

When you no longer need this booklet, please recycle it.

DPS-007132