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What is small? Small and medium enterprises facing patenting activities

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Abstract

The effect of a firm's size is analysed in relation with the probability of applying for a patent. We worked on the identification of a firm's minimum size, a threshold needed to formally protect an innovation by legal means. Below this minimum size the costs associated with protection are so high that firms prefer informal protection of their innovations. The literature concludes that as size increases so does the propensity to patent. This research finds similar results for pool regressions. In an attempt to understand the relationship between size and patent activity better, the population of firms is divided into two groups. On a first stage a firm was considered small if it had below 250 employees and large if it had more; a moving threshold was applied on a second stage. The results show that for some economies the minimum threshold needed for filing a patent is well below 250 employees[1].

JEL Classification: 031, 034, C01.

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1 Introduction

There is a recurrent issue in the literature dealing with SMEs, innovation and patents. This issue is that SMEs need to be specifically targeted through appropriate policy instruments to help them overcome various difficulties related to small size which is associated with a weak propensity to patent (Baldwin and Hanel [2003], Arundel and Kabla [1998], Arundel and Steinmuller [1998], Byma and Laiponen [2007]). It seems obvious that, as with many other kind of activities (R&D, marketing, etc.), the IPR activity of SMEs is largely influenced by economies of scale and the peculiar nature of costs associated with creating and running an IPR department or desk within the company. However, it is not clear what the critical size is, above which the impact of economies of scale on the decision to have a patenting activity no longer have any effect. Economies of scale are reductions in average unit costs attributable to increases in the scale of output. As a very specific activity, the creation and operation of an IPR department is subject to particular sources of economies of scale; the dimensions of scale that matter are specific; and the scale at which unit costs cease to fall (the minimum efficient scale or MES) is expected to be different from the MES characterising the other functional activities of the firms (R&D, manufacturing, marketing). This paper addresses this issue by asking “what is small?”, referring to the decision about whether to open and establish an IPR service or desk.

To investigate the relationship of size with the probability of filing a patent, we compared pool regressions including all the firms independent of their size with a regression dividing the firm population by size. The first result found was that our sample gave the expected results for pool regression, i.e. size is an important determinant in applying for a patent. In trying to understand the relationship between size and patent activity better, the paper splits the population of firms into two groups: a firm was considered small if it had below 250 employees and large if it had more; a moving threshold was applied on a second stage (from 20 to 280 employees). The effect of moving this threshold reveals that for some economies the MES is reached at a size much smaller than expected (40-50 employees).

This paper uses firm level data from CIS 3 (2000) data for seven European countries (Sweden, Belgium, Portugal, Norway, Netherlands, Italy and Germany) and KOF (2005) data for Switzerland.

The paper is structured as follows: section 2 builds on the scarce literature to discuss some conjectures about the effect of size on the propensity to apply for patents; section 3 presents

some empirical facts using Switzerland and Italy as examples; section 4 presents the methodology; and section 5 discusses the results and conclusions.

2 On scale effects and other handicaps

The development of an in-house service for IPR is an activity which is characterised by strong indivisibilities as a source of economies of scale: the cost of running this service is at least partly independent of scale; it is partly indivisible with respect to output and more precisely to innovation. As the relevant dimension of scale is increased (in our case R&D and innovative activities), these fixed costs can be spread over a larger output and the cost of the IPR service per unit innovation is therefore reduced. Such indivisibility is therefore a major reason why small firms rationally avoid internalising IPR services.

Another important source of economies of scale in this activity involves the specialisation effect. An increase in size of the R&D and patenting activity allows for investment in more specialised and sophisticated staff. In a small firm, the small number of people working in IPR service requires them to be able to do a little of everything, while a large structure produces the condition for more specialised skills and competences, leading to the usual efficiency gains expected from specialisation.

Superior techniques for organising activities and learning effects are other sources of economies of scale as the size of the IPR service increases. The nature of costs associated with implementing an IPR desk or service is also an important factor impeding internalisation, as these are sunk costs. Trying to protect innovation abroad means not only learning about filing a patent in other countries but meeting translation costs.

The literature focuses also on the particular handicap small firms face when involved in litigation cases. Since the resources that SMEs can devote to patents are scarce, the fact that a patent can potentially be litigated might discourage the SME. Lanjouw and Schankerman (2001) reflect on the fact that the cost of litigation over intellectual property assets diminishes their value and the incentive to invest in research. They investigate the characteristics of patent litigation and conclude that the risk of litigation increases with the value of the patent, especially if the patent is highly cited. More relevant for our purposes is their later work, in which they analyse litigation and SMEs (Lanjouw and Schankerman, 2004). Focusing on North American SMEs they observe that those firms with a large patent portfolio have a lower

probability of being subject to litigation. Consistent with these findings is the idea that the cost of patent litigation dissuades smaller firms from patenting. - Using the Carnegie Mellon Survey, Cohen (2000) shows a positive and significant relationship between firm size and the cost of defending a patent in court as a reason for not applying for a patent. These findings may suggest that larger firms are better able to spread the fixed costs of defending patents over greater levels of output.

3 Empirical facts

In general, the relationship between size and innovation has been largely investigated by empirical research (for a recent review, see Cohen [2010]). The general conclusion is that, as size increases, so does the innovation of the firm (measured as input, R&D or as output, number of innovations or patents). There is much evidence in many countries that the proportion of innovative SMEs applying for patents is low or, in other words, the literature finds a lot of countries in which the propensity to file a patent increases with the size of the firms. Studies can be found for Canada (Baldwin and Hanel [2003]), Europe (Arundel and Kabla [1998] and Arundel and Steinmuller[1998]), Finland (Byma and Laiponen [2007]) and Norway (Iversen [2003]).

Is this the case for a targeted policy? Economists dislike the design and application of “non neutral policies” to address technological and sectoral heterogeneities, because such non-neutral resource allocation is expected to generate distortions and failures (picking winners, wrong choices), being less radical as non-neutrality concerns size differences. An acknowledged and widely approved (or at least tolerated) policy departure from neutrality is seen in the provision of differing support to the innovative activities of firms in the different size-distribution range. The economic rationale for making such a distinction derives from the observation that large companies are usually considered as a relatively “efficient” solution for many of the problems raised by the allocation of resources in R&D and other innovation activities. Small firms, given their constrained resources, are likely to have greater difficulties in overcoming the various conditions that create the potential for market failures.

We need to understand what a small sized firm is. The conventional EU's definition of a SME is one with less than 250 employees[2]. If a firm has a number of employees below 50 it is considered small, and if the number is between 50 and 250 it is considered a medium sized

[2] See SME definition: Commission Recommendation of 06 May 2003

firm. Policy implications are derived from this classification, with the understanding that firms in these subgroups have similar characteristics facing similar limitations: difficulties in benefiting from economies of scale, reaching the MES and creating the potential for market failures.

The general understanding is that, as the firm increases in size, it increases its capacity to file patents to protect its innovations. Table 1 and Table 2 provide data on this issue.

Table 1. Probit regressions on the probability of filing a patent according to size. Based on Swiss KOF data (2005).

VARIABLES	(1) POOL All firms	(2) marg. eff.	(3) SME (No emp≤250)	(4) marg. eff.	(5) Big (No emp<250)	(6) marg. eff.
Size (log employees)	0.214***	0.0525***	0.229***	0.0549***	0.0762	0.0296
R&D	0.0742***	0.0182***	0.0785***	0.0188***	0.0530**	0.0206**
Marketing	0.225**	0.0582*	0.232*	0.0587*	0.0481	0.0187
International market	-0.0953	-0.0226	-0.0538	-0.0126	-0.293	-0.110
Cooperation	0.0710	0.0177	0.0226	0.00546	0.304	0.118
Clients as information	0.184*	0.0452*	0.210*	0.0506*	-0.0121	-0.00470
Universities as inform.	0.337***	0.0913**	0.290**	0.0764*	0.443	0.174
Manuf High Tech	-2.250***	-0.222***	-2.421***	-0.233***	-0.391	-0.143
Medium High Tech	-2.169***	-0.311***	-2.354***	-0.323***	-0.524	-0.195
Medium Low Tech	-2.491***	-0.244***	-2.515***	-0.249***	-1.744**	-0.439***
Low Tech	-2.870***	-0.301***	-2.913***	-0.310***	-1.899**	-0.490***
Electricity	-3.702***	-0.174***			-2.454**	-0.433***
Market Serv Low	-3.114***	-0.234***	-3.059***	-0.227***	-2.407**	-0.496***
Financial Services	-4.705***	-0.235***			-3.218***	-0.504***
Mark Services	-3.096***	-0.218***	-3.106***	-0.222***	-2.370**	-0.440***
High Tech Services	-3.285***	-0.190***	-3.390***	-0.182***	-1.934*	-0.431***
Nace - other	-3.137***	-0.278***	-3.270***	-0.295***	-1.739*	-0.439***
Observations	1048	1048	799	799	197	197

With *** if the coefficient is statistically significant below the 1% level, ** if below the 5% level and * if below the 10% level.

Table 2. Probit regressions on the probability of filing a patent according to size. Based on ITALY CIS III data (2000).

VARIABLES	(1) POOL All firms	(2) marg. eff.	(3) SME (No emp≤250)	(4) marg. eff.	(5) Big (No emp<250)	(6) marg. eff.
Size (log employees)	0.153***	0.0339***	0.174***	0.0340***	0.0680	0.0150
R&D	0.130***	0.0288***	0.131***	0.0256***	0.125***	0.0446***
Marketing	0.429***	0.108***	0.438***	0.0997***	0.456***	0.167***
International market	-0.230*	-0.0454**	-0.185	-0.0327	-0.313	-0.103
Cooperation	0.150***	0.0350**	0.156**	0.0327**	0.141	0.0509
Clients as information	0.0356*	0.00789*	0.0146	0.00286	0.107**	0.0381**
Universities as inform.	0.0871***	0.0193***	0.106***	0.0208***	0.0299	0.0107
Manuf High Tech	-1.982***	-0.171***	-2.082***	-0.149***	-0.983**	-0.255***
Medium High Tech	-1.813***	-0.228***	-1.943***	-0.200***	-0.931**	-0.285***
Medium Low Tech	-1.946***	-0.220***	-2.021***	-0.197***	-1.234***	-0.320***
Low Tech	-2.170***	-0.270***	-2.177***	-0.245***	-1.779***	-0.397***
Electricity	-3.260***	-0.147***	-3.229***	-0.123***	-2.527***	-0.333***
Market Serv Low	-2.402***	-0.185***	-2.476***	-0.158***	-1.682***	-0.353***
Financial Services	-3.158***	-0.196***	-2.950***	-0.153***	-2.742***	-0.476***
Mark Services	-2.933***	-0.157***	-2.801***	-0.131***	-2.757***	-0.355***
High Tech Services	-2.474***	-0.165***	-2.517***	-0.142***	-1.933***	-0.333***
Nace - other	-2.151***	-0.194***	-2.232***	-0.172***	-1.340***	-0.312***
Observations	5763	5763	4843	4843	920	920

With *** if the coefficient is statistically significant below the 1% level, ** if below the 5% level and * if below the 10% level.

Tables 1 and 2 present probit regressions on the probability of filing a patent. Table 1 has results for Switzerland and Table 2 for Italy. These two tables are examples to introduce the methodology. We have used two countries, because we are using two similar data sources: KOF (for Switzerland) and CIS (for the rest of the European countries). Although both sources are similar in their definition and application procedures, which make them comparable, some of the variables are defined in a slightly different way (for more details, see Annex 2). Table 3 gives a list of the covariates used in the regression. The election of the covariates is not a trivial one, is has been done partially based on covariates used in similar studies, and partially on the availability from the data set used (for a more detailed description see Annex 2).

Table 3. Description of the covariates used in the regression

Variable	Explanation	mean	Stand. Dev.
Size	Logarithm of the number of employees.	3.790	1.262
R&D	Logarithm of the number of employees.	3.816	5.561
Marketing	The firm makes an investment on marketing.	0.019	0.394
International market	The firm declares having some activities in the international market (sigmar=4)	0.224	0.417
(Switzerland)	The firm declares having economic activity outside Switzerland.	0.425	0.256
Cooperation	The firm reports having some cooperation with other agents in innovation.	0.258	0.438
Clients	The firm reports that clients are an important source of information in the innovation process.	0.679	0.467
University	The firm reports that universities are an important source of information in the innovation process.	0.31983	0.466
Industry dummies	Based on NACE (2 digits)		
Manufacture			
High tech	30+32+33	0.030	0.171
Medium high tech	24+29+31+34+35	0.131	0.337
Medium low tech	23+25+26+27+28	0.142	0.359
Low tech	15+16+17+18+19+20+21+22+36+37	0.332	0.471
Electricity	40+41	0.020	0.141
Services			
Market service low	51+60+63	0.041	0.198
Financial services	65+66+67	0.033	0.179
High tech services	64+72+73	0.046	0.210
Low tech services	50+60+63	0.207	0.406

Three probit regressions are run in both tables (1 and 2), column (1) has the results of a pool regression for all firms , with the marginal effects associated with them in column (2). Column (3) is for a medium or small sized firm, whose number of employees is less than or equal to 250 and the marginal effects associated with these are in column (4). Columns (5) and (6) report on firms with more than 250 employees and the marginal effects associated with this estimation. As mentioned above, Table 1 is for Switzerland and Table 2 for Italy.

Looking at the pooled regression in columns (1) and (2) from both tables, the first line shows that the effect of size is significant for both countries. The marginal effect of increasing the number of employees by one percent takes the value of 0.0525 for Switzerland and 0.039 for Italy. This same rule applies to patents: if employment increases by one perceptual point, the average probability of applying for patents will increase by 0.0525 in Switzerland and by 0.039 in Italy. In both cases these values are statistically significantly below the 1% level. The conclusion that size is relevant could be drawn from this regression, irrespective of the size of the firm; if it grows there is a chance of increasing the propensity to patent its innovations. Our study however suggests something different. To introduce the general empirical idea of the paper, we have added the rest of the columns in the paper. Dividing the sample population in two subgroups, small and medium sized firms (below or equal to 250 employees) and large firms (above 250), we ran another probit analysis on the propensity to patent using the same covariates as before. Looking again at size, we observed that, while for small and medium firms size is still a relevant variable for the patenting activity, for big firms this was no longer the case. This means that, moving from 10 to 250 employees an increasing capacity of firms to apply for patents is seen. This is not the same for the subgroup of big firms, as size is no longer an important factor. In other words, we observe the same probability of patenting, from a statistical point of view, for a firm that has 251 employees as for one much bigger. This result that is observed when the population of firms is split cannot be observed in the pool regression. Therefore, size is important in relation to the patent activity of a firm, but up to a limit as size is irrelevant for large firms. The question that is naturally raised here is: what is the limiting number of employees for size to become irrelevant, in relation to patents. What is the threshold in terms of size that a firm needs to reach to overcome the difficulties associated with patent activities?[3] The next section deals with the methodology used to tackle this question.

[3] See section 2 for a discussion on problems related to size and patent activities.

4 Methods

Table 1 and Table 2 in the previous section contained results relating the probability of filing a patent with a set of covariates. Table 1 concerned Switzerland and Table 2 related to Italy. In both tables, columns 1 and 2 are related to a pooled regression of all firms considered together. Columns 3 and 4 are for firms with 250 or less employees, and columns 5 and 6 for firms with more than 250 employees. As a threshold 250 was used, as it is the official number used by the EU to classify SME and large firms. It was observed that size was relevant for firms below this threshold but not for firms above it. This section changes this threshold number from 20 to 280 to establish the limit, above which firm size is irrelevant. The first limit figure of 20 for a small firm was taken, and a probit regression was run, similar to tables 1 and 2, columns 3-7. The process was repeated with 25 as the threshold, and so on.

The following tables (3) and (4) report the value of the beta and its significance for the probability of applying for a patent. In a similar framework to the exercise in Table 1, where two probit regressions were run: one for small firms (below 250 employees) and one for big firms (above 250 employees). Table (1) gives a beta coefficient of 0.229, significant at the 1% level, for small firms, and 0.0762 for large firms, and not significant. The next tables include data from different regressions with a changed threshold number dividing a small from a large firm. The initial figure is 20 for running a regression for firms smaller than 20 employees and another regression for firms larger. The idea is to see the significance of size, and how it changes as the threshold increases through the range of 20 to 280. The exercise is repeated at country level with the same variables used in the previous section, but with the sectoral dummies being replaced by a single constant[4].

The first line of the table reports the number 20 as differentiating between a small firm and a large firm in Switzerland. For the subgroup of firms below 20 employees, there is no significant effect of size on the probability to patent (we find a beta of -0.0712, but it is not significant). However, for the subgroup of firms above 20 employees, size is significant at the 1% level (with a coefficient of 0.136). Although we only report on size, we controlled for the same covariates used in Table 1. The second row reports the same exercise using 25 as the threshold number to divide a small and large firm. This threshold is then incrementally

[4] Sometimes the number of firms in the subgroups is so small that, if we want to keep the sectoral distinction, we violated the Eurostat confidentiality threshold, having less than 10 firms that are possible to be identified. When using the sectoral dummies for very small groups, there are cases where there are less that 10 firms for some of the sectoral distinctions. To overcome this problem we dropped the sectoral distinction for all European countries and also for Switzerland to keep the exercise comparable, and substituted it for a single constant.

increased up to 280. The exercise is repeated for each country and reported in the following two tables.

Table 3. Estimations of the beta value and significance of size in relation to the probability of firms filing a patent. Splitting the population according to size and running a probit for those firms less than or equal to a critical size, and those above it.

Beta (ln Emp)	Switzerland		Sweden		Belgium		Spain	
Critical Size	Below	Above	Below	Above	Below	Above	Below	Above
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
20	-0.072	0.136***	1.096*	0.112**	-1.848	0.198***	0.590	0.005
25	-0.052	0.121***	0.535	0.116**	-1.725	0.157***	0.041	-0.016
35	-0.090	0.088*	0.084	0.097*	-0.269	0.204***	0.170	-0.031
40	0.053	0.091*	0.037	0.079	-0.256	0.200***	0.220	-0.021
45	0.134	0.090*	0.039	0.075	-0.395	0.150**	0.178	-0.031
50	0.081	0.062	0.211	0.085	-0.284	0.136*	0.179	-0.029
55	0.120	0.060	0.227	0.087	-0.362	0.106	0.228**	-0.023
60	0.131	0.057	0.232*	0.091	-0.300	0.103	0.220**	-0.022
65	0.066	0.030	0.197	0.059	-0.252	0.118	0.219**	-0.011
70	0.050	0.008	0.212*	0.079	-0.303	0.063	0.218***	-0.009
75	0.067	-0.013	0.205*	0.068	-0.302	0.039	0.228***	0.017
80	0.093	-0.015	0.217*	0.082	-0.255	0.024	0.189***	0.008
85	0164*	0.004	0.235**	0.111	-0.225	0.028	0.178**	0.006
90	0.175*	0.006	0.241**	0.118	-0.206	0.029	0.177***	0.014
95	0.148	-0.021	0.223**	0.098	-0.096	0.038	0.172***	0.018
100	0.131	-0.048	0.195*	0.098	-0.116	-0.036	0.164***	0.019
105	0.163*	-0.051	0.173*	0.113	-0.100	-0.082	0.166***	0.032
110	0.213**	-0.027	0.133	0.076	0.004	-0.079	0.155***	0.029
115	0.244***	-0.004	0.121	0.068	0.020	-0.082	0.144**	0.024
120	0.236***	-0.015	0.147	0.084	0.022	-0.082	0.146***	0.037
125	0.198**	-0.065	0.188**	0.138	0.015	-0.089	0.138**	0.029
130	0.210***	-0.054	0.188**	0.153	0.008	-0.085	0.138**	0.039
135	0.221***	-0.049	0.147*	0.135	0.005	-0.087	0.123**	0.031
140	0.244***	-0.023	0.144*	0.131	0.003	-0.088	0.120**	0.037
145	0.226***	-0.052	0.132	0.118	0.041	-0.068	0.111**	0.035
150	0.223***	-0.058	0.141*	0.132	0.058	-0.062	0.114**	0.053
155	0.226***	-0.059	0.132	0.156	0.070	-0.046	0.110**	0.064
180	0.269***	0.006	0.112	0.139	0.111	-0.022	0.106**	0.085
205	0.246***	-0.010	0.108	0.152	0.139	0.002	0.082*	0.085
230	0.235***	-0.017	0.088	0.122	0.144*	0.018	0.072*	0.090
255	0.236***	-0.019	0.092	0.164	0.136*	-0.005	0.038	0.067
280	0.218***	-0.064	0.097	0.160	0.121	-0.011	0.035	0.056

With *** if the coefficient is statistically significant below the 1% level, ** if below the 5% level and * if below the 10% level.

Table 4. Estimations of the beta value and significance of size in relation to the probability of firms filing a patent. Splitting the population according to size and running a probit for those firms less than or equal to a critical size, and those above it.

Beta (lnEmp)	Norway		Netherlands		Italy		Germany	
Critical Size	Below (1)	Above (2)	Below (3)	Above (4)	Below (5)	Above (6)	Below (7)	Above (8)
20	-0.217	0.108***	-0.450	0.123***	0.340	0.162***	0.600	0.194***
25	-0.131	0.108**	-0.067	0.130***	0.262	0.156***	0.052	0.187***
35	-0.068	0.101**	-0.092	0.136***	0.226**	0.137***	-0.010	0.197***
40	-0.101	0.083	-0.061	0.135***	0.312***	0.145***	0.205	0.207***
45	-0.099	0.070	-0.082	0.133***	0.314***	0.151***	0.152	0.217***
50	0.019	0.075	-0.054	0.134***	0.298***	0.152***	0.085	0.222***
55	0.082	0.074	-0.117	0.118***	0.306***	0.156***	0.113	0.229***
60	0.143	0.086	-0.040	0.123***	0.298***	0.158***	0.091	0.230***
65	0.127	0.083	-0.024	0.118***	0.311***	0.176***	0.100	0.236***
70	0.210**	0.129*	-0.021	0.109***	0.297***	0.175***	0.094	0.236***
75	0.213**	0.152**	0.006	0.106**	0.288***	0.162***	0.095	0.229***
80	0.240***	0.192***	-0.003	0.100**	0.265***	0.150***	0.053	0.212***
85	0.225***	0.210***	0.006	0.099**	0.258***	0.154***	0.034	0.207***
90	0.207***	0.201**	0.035	0.104**	0.225***	0.133***	0.022	0.194***
95	0.191**	0.204**	0.059	0.104**	0.225***	0.133***	0.016	0.190***
100	0.170**	0.192**	0.055	0.102**	0.233***	0.144***	0.018	0.183***
105	0.127*	0.153*	0.087	0.104**	0.227***	0.134***	0.037	0.184***
110	0.154**	0.205**	0.088	0.108**	0.219***	0.133***	0.039	0.189***
115	0.127*	0.176*	0.081	0.109**	0.234***	0.142***	0.032	0.180***
120	0.124*	0.182*	0.081	0.109**	0.241***	0.146***	0.047	0.181***
125	0.118*	0.191*	0.091	0.122**	0.240***	0.148***	0.089	0.200***
130	0.100	0.163	0.097	0.129**	0.236***	0.146***	0.081	0.191***
135	0.075	0.125	0.080	0.115**	0.242***	0.153***	0.085	0.187***
140	0.057	0.088	0.061	0.095*	0.232***	0.149***	0.064	0.173***
145	0.040	0.042	0.071	0.096	0.239***	0.161***	0.105	0.185***
150	0.067	0.100	0.067	0.090	0.235***	0.171***	0.085	0.166***
155	0.075	0.089	0.075	0.093	0.232***	0.171***	0.079	0.162***
180	0.062	0.019	0.095*	0.114*	0.223***	0.167***	0.058	0.142**
205	0.069	-0.059	0.096**	0.124*	0.211***	0.146**	0.110*	0.149**
230	0.070	-0.122	0.094**	0.113	0.202***	0.132**	0.123**	0.159**
255	0.089*	-0.076	0.097**	0.121	0.188***	0.080	0.119**	0.145**
280	0.087*	-0.148	0.101**	0.133	0.188***	0.073	0.104*	0.081

With *** if the coefficient is statistically significant below the 1% level, ** if below the 5% level and * if below the 10% level.

The most interesting point in the table is when the size for the group of firms above the threshold number becomes insignificant. Looking at Switzerland; size is not significant for firms with above 50 employees. After this threshold, firm size is no longer significant and firms with above 50 employees file patents with equal intensity. In other words, there is no longer any scale difference for a firm with 50 employees and another with 25000, for example. At least we find no statistical significance difference in this subgroup. Looking at table 3 column (1), size starts being significant at 85 employees. In this subgroup we have firms whose size goes from 10 employees to the threshold. It means that to see a significant size effect on the patent application we need to include enough variation in relation to size in the subgroup. This basically means that very small firms are not really doing much to protect their innovation with patents, and as we include more and more big firms we can observe that there is a significant difference correlated with size. Looking again at column (2), in the line corresponding to a threshold of 50, in the subgroup of firms considered as big there are firms that go from 50 to the biggest firm in our Swiss Sample. The size distance from the smaller to the bigger is much larger than in the case of the aforementioned threshold of 85. In this case, the distance goes from 10 (min size of the sample) to 85. We want to highlight that firms over 50 employees are heavily involved with patents, but size is no longer significant as we have passed a threshold.

The rest of the countries follow a similar pattern to Sweden (with a size threshold of 40), Belgium (threshold of 55), Spain (where for big firms it is never significant), Norway (the threshold is reached at 130). All these countries reach a MES at a size that is below the conventional definition of a SME. In some other economies, like Netherlands (205), Italy (230) and Germany (250), the size threshold is much closer to the definition of an SME. This therefore makes it easier for old innovators to file for patents in a cumulative creation of knowledge. The most relevant point is that these data show that there are significant country differences in the dynamics of firms applying for patents.

5 Conclusions & implications for policy

This paper investigates the relationship between size of firms and application for patents. We see that in some countries (Switzerland, Sweden, Belgium), firms are “large” (that is, above a critical size) at a relatively low level in terms of the number of employees (between 40 and 50). In some other countries (Italy, Germany), firms are “small” at a relatively high level of number of employees. This means that for any of the reasons (discussed) below, policy should focus on the small firms in the first group of countries, but in the second group it should focus on the small and medium size firms.

There are several possible reasons for this. It may be that some economies are more innovative than others (for historical reasons, a more productive national system of innovation, etc). Therefore, more innovation uniformly distributed across firm size would be expected. We observe a higher participation of firms even if they are not very big (as with Switzerland, Sweden and Belgium). Another possible reason, left for future research, is that specific policies are carried out in these countries that involve a set of facilities for SMEs (higher diffusion of how the patent system works, lower fees, simpler procedure to file patents for small firms, etc). This could, at least, partially explain the differences in the importance of size across countries.

The differences in critical size point to some competitive advantages for some countries. If smaller firms are able to better protect their innovation in some countries than in others. This justifies generating a higher degree of new knowledge in those countries. Assuming that knowledge creation is one of the main sources of growth in an economy, this facilitates the protection of knowledge which may be translated into a subtle means for imperfect international competition.

This paper shows some empirical evidence that the effect of size is very different from one country to another. It shows that the size effect disappears and does not seem to be an issue for large firms. It points to a critical size needed to become an active user of patents. This critical size varies very much from one country to another.

These results are useful for answering in a more rigorous way the question “what is small?” regarding the propensity to patent. It should therefore help policy makers to avoid acting on the basis of a casual understanding, uninformed by systematic empirical inquiries into the processes of patent application by “small” companies. Our partial results show that there is room to increase effectiveness: in some countries subsidising patent activities in all companies matching the standard definition of SMEs would just result in the transfer of the cost of patenting to the government without any allocative effect. In some countries like Switzerland, the gap between the critical size (in terms of patent propensity) and the maximum size corresponding to a standard definition of SME is huge, providing a good case for increasing the effectiveness of policy by designing a public support programme which would only target firms below 40 employees, not below 250 or 500. And because all costs must be considered, such a policy would save a significant fraction of the cost of public funding in the area of innovation policy.

Therefore, in the short term, policies should be designed with different focus points across countries, while for the long term it would be needed to understand why in some countries the critical size is much smaller, and the policies that may be needed in other countries to make the critical size smaller and similar to those measured for Switzerland, Sweden or Belgium.

Of course there is no reason to think that variation in critical size across European countries is a phenomenon that would only apply to patent propensity. The development of and access to other classes of knowledge-driven activities, such as R&D, training, university research, even marketing, might provide other examples of variations between countries in terms of minimum size threshold and, as such, should offer other good cases for increasing policy effectiveness by undertaking the kind of empirical exercise we have presented here for the particular case of patent application.

Annex 1

Community Innovation Survey (CIS) and KOF survey.

The analysis is based on the micro data (firm level) of the third Community Innovation Survey (CIS3) in each country, covering the years 1998-2000 and KOF data (2005). Both surveys follow the same spirit and are implemented in similar ways. They collect information on innovation output and R&D, at least for the firms that are innovative and for all the covariates used in the research. After a few identifying questions, respondents are faced with the following central questions:

- During the last two years, has your enterprise introduced any new or substantially improved products on the market?
- During the last two years, has your enterprise introduced any new or substantially improved production processes?
- At the end of the period, did your enterprise have any ongoing innovation activities?
- During the last two years, has your enterprise abandoned any innovation activities?

A first way to characterise innovators is to consider those that responded "yes" to any of the four questions as innovators. This is in the spirit of the CIS survey, where those who responded "no" to all four questions were considered as non-innovators and did not have to respond to most of the other questions in the survey. We therefore have little information

about non-innovators. We focused on innovators, since we have no information about patent activities by non-innovators. In fact, if a firm applies for a patent it is because it is a product or process innovator.

Annex 2

Explanation of the covariates.

As commented above, we used CIS 3 and KOF (2005) data. For comparability purposes in the results, the selection of covariates is explained with special mention for differences between data bases:

- Size. It is defined as the logarithm of the number of employees working in the firm.
- R&D. Is measured as the logarithm of the total R&D performed by the firm, both internal and external. It is expected that the higher the R&D expense, the higher the probability of filing a patent.
- Marketing. Dummy variable. Takes the value of one if the firm reports investing in marketing and zero if not.
- International Market. This variable is slightly different for Switzerland and the rest of the European countries. For Switzerland, it takes the value of one if the firm reports having any economic activity outside Switzerland, and zero otherwise. For the European countries in our sample, the value of one is taken if the firm reports the international market as its most important, and zero otherwise.
- Cooperation. Is a dummy variable taking the value of one if the firm reports having some kind of cooperation with other firms or institutions, and takes the value zero if there is no such cooperation.
- We control two sources of information:
    - Clients. Takes the value of one if the firm reports that clients are an important source of information in the innovative process, and zero if not. This variable tries to capture the idea that innovation is supply driven.
    - University. If firms report that information from university is relevant in their innovation process, it takes the value of one. This is a dummy variable for the idea of basic research being relevant in the innovation process.
- Industry dummies: The idea of introducing industry dummies is to control the general process of innovation for some sector specificities. We define the following sector groupings as the two-digit NACE codes
    - Manuf High Tech: High Technology Manufacturing sectors, includes manufacture of electrical and optical equipment (30), manufacture of radio, television and communications equipment and apparatus (32) and manufacture of medical, precision and optical instruments, watches and clocks. (33)

- Medium High Tech: Medium-High Tech manufacture consists of five sectors: manufacture of chemicals (24), machinery and equipment n.e.c (29), electrical machinery n.e.c (31), motor vehicles (34) and other transport equipment (35).
- Medium Low Tech: Medium-Low Tech manufacture which includes manufacture of fuel (23), rubber and plastic products (25), other non metallic mineral products (26), basic metals (27) and fabricated metal products (28).
- Low Tech: low tech includes the manufacture of the following sectors: food and beverages (15), tobacco (16), textiles (17), clothing (18), tanning and dressing of leather and derivates (19), wood and cork (20), paper (21), recorded media (22), furniture (36) and recycling (37).
- Electricity: which includes two sectors, electricity, gas, steam and hot water supply (40) and the collection and treatment of water (41).
- Market Serv Low: market services consider to be related to low tech services which includes: wholesale trade (51), land transport (60) and support of auxiliary transport activities (63).
- Financial Services: consists of the following sectors: financial intermediation (65), Insurance and pension funds (66) and activities linked to financial intermediation (67).
- High Tech Services: the last industry dummy, consisting of services considered to be high tech, includes the following sectors: post and telecommunications (64), computer and related activities (72) and research and development (73).

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Abstract

The effect of a firm's size is analysed in relation with the probability of applying for a patent. We worked on the identification of a firm's minimum size, a threshold, needed to formally protect an innovation by legal means. Below this minimum size the costs associated with protection are so high that firms prefer informal protection of their innovations. The literature concludes that as size increases so does the propensity to patent. This research finds similar results for pool regressions. In an attempt to understand better the relationship between size and patent activity better, the population of firms is divided into two groups. A firm was considered small if it had below 250 employees and large if it had more; a moving threshold was applied on a second stage. The results show that for some economies the minimum threshold needed for filing a patent is well below 250 employees.

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