Firm size, market concentration and R&D: an empirical analysis of the Italian manufacturing firms

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Abstract

The relation between firm size, market concentration and innovation is a topic that has been much studied in the literature, however theoretical and empirical studies are still inconclusive. This paper proposes to study whether firm size and market concentration have different impact on the probability to carry out R&D efforts and to R&D intensity, taking into account learning effect and spillover. To test our hypotheses we use a panel of Italian manufacturing firms over the period 2004-2006 and find a strong relationship between firm size and innovation activity. The relationship between market concentration and innovation activity is also found with the decision to invest. However our results show that the relation between firm size, market concentration and innovation is strongly influenced by the Pavitt sectors. In fact, firms belonging in the suppler dominated and scale intensive sectors have different results from those in the specialized supplier and science based sectors.

Keywords: Firm size, market concentration, innovation, R&D, Italy.

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1. Introduction

In "Capitalism, Socialism and Democracy", Schumpeter emphasizes the importance in industrialized economies of large firms in promoting technological change. Subsequently, many economists have focused on the study of two so-called Schumpeterian hypotheses: 1) the existence of a positive relationship between innovation and monopoly power with a concomitant increase in profits, and 2) large companies are more innovative than small firms.

A lot of difficulties were encountered in testing the two hypotheses (see Kamien and Schwartz, 1982), and only few studies have taken into account of R&D spillovers in measuring these assumptions (Futia, 1980, Levin and Reiss, 1984 Audretsch and Vivarelli, 1994). The evolution of the debate has raised several issues, one of these is the importance of other sectorial characteristics able to influence this relationship. In this study we try to address this point and study these hypothesis disaggregating our data according to the Pavitt taxonomy.

The traditional interpretation of the forces driving market functioning is that a precise relationship exists between market structure, firm size and economic performance. In general, empirical evidence shows that firms operating in more concentrated sectors tend to gain higher profits relative to firms operating in markets with a lower degree of concentration. However, there are different interpretations on the possible causes of this. In a pioneeristic work Bain (1951, 1956) asserts that when concentration is higher, firms are inclined to collude or more generally to dissipate resources to create entry barriers in order to preserve their dominant position in the market. In terms of efficiency, the logic consequence is that firms operating in more concentrated markets are characterized by a lower average level of efficiency. In both empirical investigations, Bain's results were controversial: a significant relationship between barriers to entry and concentration was found, but on the other hand the effect of concentration on profitability was weak in most of the cases analysed. Following Bain's approach, a number of empirical studies have tried to establish the existence of a systematic relationship between the two variables aforementioned.

The aim of this study is to verify if firm size and the market structure influence the probability of investing in R&D and in which measure. In particular, we want to verify if the two Schumpeterian hypotheses can be estimated with a single model, since the innovative intensity is influenced both by the market structure and by the firm size.

The paper studies the Italian manufacturing sector and disaggregate the analysis according to the Pavitt taxonomy in order to take advantage of any specialized production sectors. The data we use are those contained in the X survey provided by Mediocredito Centrale-Capitalia. Two different hypotheses are studied, in the first one, we test if firm size and market concentration influence the probability of a firm to invest in R&D, this hypothesis is testes through a probit model. Our second hypotheses wants to verify the role played by firm size and market concentration on R&D intensity, measured by the ratio between R&D to sales, this hypothesis is testes through a tobit model.

Results show that firm size strongly influences the probability to invest in R&D, while market concentration has not the usual impact in determining the probability to invest. On the contrary, learning effect and spillover play an important role.

The remainder of the paper is organized as follow: next section provides a survey if the related literature and clarifies the features that differentiate our work from earlier papers. Section 3 introduces our empirical model and the data used in our study. Section 4 presents and discusses our estimation results on the effects of competition and firm size on R&D intensity. Finally section 5 summarizes our results and discusses possible areas for future research.

2. Related literature

The two neo-Schumpeterian hypotheses regarding the positive relationship between innovation intensity and firm size and the innovative intensity and market concentration have been investigated in numerous studies (see for example Freeman, 1982; Baldwin and Scott, 1987; Cohen and Levin, 1989). Some studies have examined directly the impact of market structure or firm size on innovation, some other studies have focused on specific hypothesis as to why a positive effect may exist (Syrneonidis, 1996).

The relationship between firm size, innovation and market structure has been studied in the economic literature both from a theoretical and an empirical perspective, however results seem not to univocally determining this relationship. Most early studies found a more than proportional relationship between R&D and firm size, concluding that larger firms invested more in R&D compared with smaller ones. More recent studies, using different econometric techniques, conclude in a different way (for a review of the literature see Syrneonidis, 1996; Becheikh, et al. 2006; Cohen, 2010). For example,

Acs and Audretsch (1990) find a negative correlation between market concentration and innovative output and confirm the neo-Schumpterian hypothesis of a positive correlation between firm size and innovative intensity only for concentrated sectors where conditions of imperfect competition prevail. On the other hand, greater innovative intensity has been shown in small and medium-sized firm in low concentrated sectors (Archibugi et al., 1995).

According to Revilla and Fernàndez (2012) after decades of research on the relation between the effect of firm size on innovation the only consensus that seems to exist is about "the equivocal and inconclusive nature of such research". A positive link between firm size and innovation is expected given that larger firms are more likely to support higher expenses necessary for expenses activities (Cohen and Klepper, 1996; Syrneonidis, 1996; Revilla and Fernàndez, 2012). On the other side, smaller firms are more flexible compared with the larger, consequently should be better innovators (Syrneonidis, 1996; Revilla and Fernàndez, 2012). However, some recent works (Revilla and Fernàndez, 2012; Triguero and Còrcoles, 2012) highlight that the relationship between size and innovation depends on other factors such as technological regimes, previous experience, dynamic capabilities or industry-market related characteristics.

In studying the Schumpeterian hypotheses at least two problems exist: i) to find an adequate measures of innovation and ii) to identify a casual link between technological and economic variables (Archibugi et al., 1995). In the first issue it is discussed often if an input (such as R&D expenses) or output measure (the number of patents) should be used. Indicators based on R&D is a reliable proxy of innovative activity only for large-sized firms and fails to reflect technological activities prelevant in medium and small firms (Kleinknecht, 1987; Pavitt et al, 1987; Archibugi et al. 1995), moreover R&D expenses does not necessarily lead to technologically new or improved products and/or processes (Becheikh et al., 2006; Flor and Oltra, 2004). Consequently R&D is an over-estimated measure of innovation (Becheikh et al., 2006). The patents are considered sometimes less biased in favour of large firms but this indicator has the problem that not all the patended innovation are commercialized and then turned out in innovation. Patents data measures inventions rather that innovations (Becheikh et al., 2006; Flor and Oltra, 2004). According to Becheikh et al. (2006) some work developed indirect indicators of innovation (i.e. innovation count and firm-based surveys), however this measure of innovation has the disadvantages of privilege radical innovations over incremental ones and product over process innovations. The solution is that researchers

tend to develop an index that is the combination of different measures of innovation.

For what concern the second problem, the direction of causality seems not to be a relevant issues given that most of the study enphatize the one way direction of causality from market structure and firm size to innovative performances.

An additional problem that can arise studying the relationship between innovation and concentration is the endogeneity, given that the market structure affecting R&D decision is not given, but endogenously determined by technology and competition (Nelson, 2002).

3. Model and data

3.1. Hypotheses on market competition size and R&D

As introduced earlier the following analysis has the object to verify if firm size and market competition influence both the propensity to invest in R&D and the intensity of R&D investments. Henceforth, the empirical analysis is focused on the following two hypotheses:

Hypothesis 1: The probability to invest in R&D is, positively, influenced by firm size and market concentration.

The propensity to invests in R&D is measured in the following way:

$$RD_{it} = \alpha + \beta_1 Size_{it} + \beta_2 Size_{it}^2 + \beta_3 CR_{it} + \beta_4 CR_{it}^2 + \beta_5 LE_{it} + \beta_6 LE_{it}^2 + \beta_7 Z_{it} + \varepsilon_{it} \quad (1)$$

Where RD_{it} is a dummy variable, which is equal to 1 if firms had expended in R&D and 0 otherwise, $Size_{it}$ and $Size_{it}^2$ measure, respectively, the size and the size squared of the firm in order to take into account some non-linear relationship between the variables. The same is done for the concentration ratio (CR). LE represents the learning effect of a firm (for a detailed impact of Learning effect on R&D see Ray and Bhaduri, 2010). Also in this case a quadratic term is added. Finally, Z_{it} indicates a vector of control variables such as two dummy variables for the three geographical area (north, middle and

south and islands) that are included to control for regional differences due to different level of development, and three dummy variables for the four Pavitt sectors. Pavitt dummies are included because an industrial sector may have, in principle, a different production function from others; and temporal dummies are included to take into account technological progress. In the Pavitt taxonomy the sectors are classified in the following way: supplier dominated (Pavitt 1), scale intensive (Pavitt 2), specialized supplier (Pavitt 3) and science based (Pavitt 4). It is important to highlights that Italian manufacturing firms tend to be concentrated in the Pavitt 1 sector.

Hypothesis 2: Firm size and market concentration positively influences the intensity of R&D

The model that we will use in order to study this second hypothesis can be summarized in the following way:

$$RDInt_{it} = \alpha + \beta_1 Size_{it} + \beta_2 Size_{it}^2 + \beta_3 CR_{it} + \beta_4 CR_{it}^2 + \beta_5 LE_{it} + \beta_6 LE_{it}^2 + \beta_8 SP_{it} + \\ + \beta_9 Z_{it} + \varepsilon_{it} \qquad (2)$$

Where $RDInt_{it}$ represents the R&S expenditure on sales, while *SP* indicate the spillover of a firm. All other variables have the same significant of (equation 1) above.

3.2. Data description

To estimate Equation 1 and 2, we use a three-year panel taken from the X survey carried out by Mediocredito Centrale-Capitalia (MCC). The MCC is a survey that encompasses all Italian manufacturing firms with more than ten employees. The database is published every three years since 1968. The survey offers a large amount of observations on the production and financial indicators of Italian manufacturing firms. In the last survey the database considers a stratified sample of 5,137 Italian manufacturing firms. The sample is stratified according to industry, geographical and dimensional distribution for firms from 11 to 500 employees. It is by census for firms with more than 500 employees. The database contains questionnaire information on the individual firms' structure and

behaviour and three years of balance sheets data, additional data on employees, employees' education, age of the firm, turnover, etc.

Our analysis refers to the period 2004-2006. As a result, we obtained 14343 firm-year observations. Table 1 presents a description of the variables used in the empirical analysis.

As stated in the previous paragraph the dependent variable in the first estimation is a dummy variable, which is equal to 1 if firms, invests in R&D and 0 otherwise, in the second estimation the dependent variable is equal to the ratio between the R&D expenses and sales. The proxy for the size is the number of employees. The industrial concentration measure, both the CR_5, related to the five biggest firms and CR_{10}, related to the first eight biggest firms, are taken from the *Conti Economici delle imprese* (2008, 2009 and 2010).

The concentration ratio is defined as the sum of the squared market shares of the individual companies, and its main advantage is related to the fact that it takes into account both the number and the size of firms operating in a market. This measure is very sensitive to the entry or exit of big firms in the database at different times, for this reason we use the data carried out by Italian Institute of Statistics (ISTAT). In this case, the total number of firms operating in the market is not relevant for the estimation, as this index is calculated as the sum of the market shares of the *m* biggest firms in the market.

Learning through experience (LE) has been measured with the age of the firms (see Lall, 1983 and Goldar and Ranganathan, 1997), other literature measure the same variable with the age of the R&D unit of a firm. We did not use the last proxy given that me do not have this information. Our measure of spillover is the age of firm by *rd* (where *rd* is equal to one if firm invests in R&D and 0 otherwise).

To choose all the remaining variables as proxies of R&D, size and concentration index is quite common in this literature (see for example: Becheikh et al 2006; Cohen, 2010; Martìnez-Romàn et al. 2011).

The summary statistics of the variables used in the estimation are presented in Table 2.

4. Estimation results

The association between the probability to invest in R&D and size and the market concentration is reported in table 3 (Hypothesis 1). The dependent variable assumes value 1 if the firm has invested in R&D and 0 otherwise. Given that our dependent variable is 0 or 1 we estimate this hypothesis using the probit methodology. The first two columns of table 1 show the results for the whole sample while the following 8 columns show the results for the four Pavitt sector. The Table is divided in two panels, panel A considers the concentration ratio of the first 5 firms (CR5), while panel B considers the concentration ratio of the first 10 firms (CR10). Results are not very different between the two panels. As stated earlier we test an inverted U-shape relation between the concentration ratio and the probability to invest in R&D by introducing a quadratic term of the same variable. Moreover, we tested the same relation for the size of the firm and for the learning effect, always adding this quadratic term. Results show a strong relation between firm size and the probability to invest in R&D. In fact, as firm size increase, the probability to have R&D investment increases but with a decreasing rate. This result is found for the all sample and for the all Pavitt sector with the exception of the sector Pav4. The same result is also found for the learning effect. In fact, with the increase of the learning effect the probability to have positive investments in R&D increase and then decrease. This result is also found for the whole sample and for all Pavitt sector with the exclusion of the sector Pav3. For what concerns the probability to invest in R&D and market concentration, we can see that this probability increases only for the fourth Pavitt sector, while it is not significant for the sector Pav3. However, for the first two Pavitt sectors (Pav1 and Pav 2) our results, in contrast to the Schumpeterian hypothesis, show that high industry concentration is associated with fewer innovations activity by the firms. This result is in line with the result find by some previous literature (see for example: Koeller, 1995; Acs and Audretsch, 1988, 1990). The dummies for the geographic area give the expected results, showing that firms located in the centre and north of Italy are more likely to invest in R&D. One of the main result of this hypothesis state that large firms are more likely to invest in R&D, this happens for (at least) four reasons: scale economies, fixed costs, financial resources and complementary assets (Pires-Alves and Rocha, 2012).

The results of our second hypothesis are shown in table 4, in this case the dependent variable is the R&D expenditures on sales. In this case we do not find the same results as for the previous estimation. In fact, we can see that while the

concentration ratio is now of the expected sign, the variable size does not perform very well. In particular, the market concentration variable is significant only for the whole sample and for the results of the Pav1 sector. From our results we can see that large firms are associated with fewer innovations intensity (whole sample and Pav 1 sector). The Pav1 sector turn to be very important especially because almost all manufacturing firms belonging in the supplier dominated sector. Finally, spillovers turn to be very important in determining the R&D intensity.

We conduct also a series of the robustness checks, as shown in the Appendix A (tables A1–A6) we estimate the same model for each year and we do not find significant difference with the result of the panel. Given that all our estimation has three quadratic term, we estimate our two equation without this term and we did not found significant differences.

5. Concluding remarks

After a long debate on the effects of firm size and market concentration on innovation activity, there is no consensus on the relationship of the above variables.

The main purpose of this paper is to study the two Schumpeterian hypotheses for the Italian manufacturing firms taking into account also the leaning effect and spillovers. Those hypotheses state the existence of a positive relationship between innovation and monopoly power with a concomitant increase in profits, and that large firms are more innovative than small firms.

In particular, we estimated two hypotheses, in the first one we study the impact of firm size and market concentration on the probability to invest in R&D, in the second hypothesis we study the impact of the same variables on the intensity of R&D, namely the R&D intensity equal to the ratio of R&D expenses and sales.

The results of the estimation of the first hypothesis confirm that firm size is a variable very important in determining the probability to invest in R&D. This result can be the due to the importance of small firms in the Italian manufacturing sector and their lack of R&D efforts. On the other side market concentration has not the usual impact on the probability to invest in R&D. In fact, our results show that if market concentration increases the probability to invest is smaller. However, the learning effect variable shows the same impact as size. Turning to the second hypothesis, namely the impact of firm size and market concentration on the intensity of R&D, we can see the

size of the firms decreases the probability to invest while market concentration and spillover effect turn to be very important.

To summarize the purpose of this paper is to study the two Schumpeterian hypotheses taking into account both the probability to invest and the intensity of the investment in R&D. We have also shed some light influence of those variables in the four Pavitt sector of the Italian manufacturing firms. Our results highlights the attention that large firms receive from the policy makers compared with the smaller ones.

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Table 1: Definition of variables

Variables	Definition	Hp
Dependent variables		
RD	equal to 1 if firm had invested in R&D and 0 otherwise	..
RDInt	R&D expenses on sales, 0 otherwise	..
Independent variables		
lnCR5	concentration measure related to the first 5 firms in the sector	+
lnCR52	CR5 squared	-
lnCR10	concentration measure related to the first 10 firms in the sector	+
lnCR102	CR5 squared	-
lnsize	logarithm of the number of employees	+
lnsize2	logarithm of the number of employees squared	-
lnage	logarithm of the number of firm's age	+
lnage2	logarithm of the number of firm's age squared	+/-
lnagerd	logarithm of the number of firm's age by RD	+
North	dummy variable equal to 1 if firms is located in the North of Italy	+/-
Centre	dummy variable equal to 1 if firms is located in the Centre of Italy	+/-
South	dummy variable equal to 1 if firms is located in the South of Italy	+/-
Pav1	supplier Dominated	+/-
Pav2	scale intensive	+/-
Pav3	specialized supplier	+/-
Pav4	science based	+/-

Table 2: Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
rd	14343	.55804	.49664	0	1
rdint	14343	.02338	.30953	0	29.023
Independent variables					
lnpri5	13628	2.0005	.85845	.40547	4.4128
lnpri10	13628	2.3816	.77727	.91629	4.4613
lnpri5s	13628	4.7390	3.4000	.16440	19.473
lnpri10s	13628	6.2759	3.6137	.83959	19.903
lnsize	13940	3.5451	1.1267	0	9.3927
lnsize2	13940	13.837	9.3391	0	88.222
lnage	13885	2.9588	.89084	0	5.5452
lnage2	14009	5.8718	1.8406	0	11.090

Table 3: Size, market concentration and the probability to invest in R&D. Dependent variable: *RD*.

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	0.048	0.142	-0.293***	0.093	-7.251***	2.320	-0.908	4.399	6.164**	3.103
lnCR5sq	0.005	0.035	0.047*	0.025	1.276***	0.420	0.381	1.133	-0.977*	0.506
lnsize	1.478***	0.128	0.830***	0.111	2.771*	0.159	4.867***	1.431	-0.276	0.320
lnsizesq	-0.139***	0.015	-0.072***	0.013	-0.267*	0.163	-0.444***	0.209	0.057	0.039
lnage	1.367***	0.115	0.788***	0.144	2.193***	1.731	2.263	1.484	-0.497	0.417
lnagesq	-0.196***	0.023	-0.098***	0.020	-0.226	0.279	-0.261	0.424	0.161**	0.076
Centre	0.338***	0.093	0.328**	0.068	1.259	1.165	0.199	1.134	1.020***	0.219
South	-0.124	0.115	-0.065	0.075	-0.110	0.818	-2.059	1.399	1.320***	0.384
Cons.	-5.592***	0.299	-2.902***	0.250	0.096	5.629	-14.789***	5.743	-9.310**	4.733
Obs.	12886		6048		2574		3633		631	
Wald chi(2)	521.57	0.000	351.42	0.000	20.26	0.009	77.43	0.000	66.92	0.003
					Panel B: CR10					
lnCR10	-0.532***	0.228	-0.390***	0.136	-23.70***	4.704	-1.381	7.403	10.414***	4.305
lnCR10sq	0.125***	0.048	0.058*	0.030	3.940***	0.732	0.374	1.663	-1.537**	0.650
lnsize	0.918***	0.154	0.830***	0.110	6.197*	1.131	3.317***	1.427	-0.349	0.319
lnsizesq	-0.081***	0.019	-0.072***	0.013	-0.525***	0.135	-0.279	0.220	0.065	0.040
lnage	0.631***	0.146	0.788***	0.104	5.608***	1.084	2.745*	1.448	-0.517	0.417
lnagesq	-0.063***	0.028	-0.098***	0.019	-0.691***	0.215	-0.341	0.352	0.169**	0.076
Centre	0.338***	0.102	0.328**	0.068	3.578***	0.678	0.293	1.522	1.164***	0.227
South	-0.132	0.123	-0.065	0.075	-0.965	0.679	-2.443	1.581	1.305***	0.374
Cons.	-2.735***	0.462	-2.703***	0.273	0.096	5.629	-10.970***	9.551	-17.032**	7.089
Obs	12886		6048		2574		3633		631	
Wald chi(2)	188.81	0.000	351.53	0.000	244.75	0.009	56.21	0.000	75.19	0.000

Note: Robust standard errors on the right hand side.

Table 4: Size, market concentration and the intensity of R&D investments. Dependent variable: *RDInt*.

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	0.008*	0.005	0.015***	0.006	0.030	0.031	-0.009	0.016	0.169	0.240
lnCR5sq	-0.002*	0.001	-0.004***	0.001	-0.006	0.006	0.002	0.004	-0.027	0.039
lnsize	-0.012***	0.005	-0.010	0.007	-0.009	0.010	-0.015*	0.008	-0.032	0.028
lnsizesq	0.002***	0.001	0.001	0.001	0.001	0.001	0.002**	0.001	-0.004	0.003
lnage	-0.005	0.001	-0.014**	0.006	0.012	0.011	-0.003	0.009	0.009	0.039
lnagesq	-0.002	0.0008	0.001	0.001	-0.002***	0.001	-0.0008	0.002	0.002	0.006
lnageRD	-0.008***	0.001	-0.009***	0.001	0.001	0.002	-0.008***	0.001	0.002	0.006
Centre	0.0002	0.003	-0.0002	0.004	0.001	0.007	-0.008	0.007	0.046**	0.024
South	0.002	0.004	0.0002	0.005	0.001	0.007	-0.010	0.009	-0.001	0.033
Cons.	0.037***	0.012	0.044***	0.016	-0.034	0.049	0.051**	0.025	-0.176	0.371
Obs.	12886		6048		2574		3633		631	
Wald chi(2)	116.87	0.000	71.93	0.000	33.52	0.000	42.57	0.000	7.62	0.572
					Panel B: CR10					
lnCR10	0.014***	0.007	0.024***	0.009	0.043	0.046	-0.014	0.021	0.0.9	0.365
lnCR10sq	-0.003**	0.014	-0.005	0.001	-0.008	0.007	0.003	0.004	-0.017	0.055
lnsize	-0.012***	0.004	-0.010	0.007	-0.010	0.010	-0.015*	0.008	-0.032	0.028
lnsizesq	0.002***	0.001	0.001	0.001	0.001	0.001	0.002**	0.001	0.004	0.003
lnage	-0.005	0.005	-0.014**	0.144	0.011	0.011	-0.003	0.010	0.012	0.039
lnagesq	-0.002	0.001	-0.001	0.001	-0.002	0.001	-0.001	0.001	-0.004	0.007
lnageRD	0.008***	0.0008	0.009***	0.001	0.008***	0.001	0.008***	0.001	0.002	0.006
Centre	0.0005	0.003	-0.0001	0.004	0.001	0.007	-0.008	0.007	0.002	0.005
South	0.002	0.004	0.0003	0.005	0.021***	0.008	-0.001	0.009	0.047*	0.023
Cons.	0.029**	0.013	0.031*	0.017	-0.054	0.076	0.056*	0.033	-0.092	0.601
Obs	12886		6048		2574		3633		631	
Wald chi(2)	118.41	0.000	73.55	0.000	34.48	0.009	42.41	0.000	7.23	0.613

Note: see table 3.

Appendix A

Table A1: Size, market concentration and the probability to invest in R&D. Dependent variable: *RD*. Year 2004

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	-0.184**	0.080	-0.248**	0.114	-1.810***	0.712	0.031	0.278	6.113**	2.922
lnCR5sq	0.047**	0.020	0.045	0.030	0.344***	0.131	0.001	0.08	-0.961**	0.475
lnsize	0.618***	0.086	0.673***	0.154	0.589***	0.172	0.678***	0.149	0.050	0.348
lnsizesq	-0.055***	0.010	-0.062***	0.019	-0.055***	0.019	-0.058***	0.013	0.009	0.039
lnage	0.375***	0.088	0.248**	0.114	0.716***	0.199	0.359**	0.176	-0.422	0.485
lnagesq	-0.041***	0.017	-0.039	0.025	-0.099***	0.036	-0.032	0.034	0.134	0.095
Centre	0.217***	0.059	0.175**	0.086	0.339***	0.119	0.154	0.136	0.829***	0.307
South	-0.062	0.069	-0.017	0.105	-0.072	0.130	-0.293***	0.151	0.629*	0.370
Cons.	-1.895***	0.207	-1.816***	0.325	-0.052	1.044	-2.261***	0.455	-9.72**	4.461
Obs.	3760		1569		843		1140		208	
Wald chi(2)	220.51	0.000	81.02	0.000	59.26	0.000	85.72	0.000	22.87	0.003
					Panel B: CR10					
lnCR10	-0.271**	0.171	-0.333**	0.163	-2.855***	1.125	0.039	0.373	9.223**	4.345
lnCR10sq	0.060**	0.025	0.057	0.036	0.475***	0.181	0.001	0.08	-1.350**	0.659
lnsize	0.619***	0.086	0.673***	0.154	0.587***	0.173	0.679***	0.150	0.052	0.348
lnsizesq	-0.055***	0.010	-0.062***	0.019	-0.055***	0.019	-0.058***	0.017	0.009	0.039
lnage	0.375***	0.088	0.317***	0.126	0.719***	0.198	0.359**	0.176	-0.452	0.493
lnagesq	-0.041***	0.016	-0.038	0.024	-0.099***	0.035	-0.032	0.034	0.140	0.097
Centre	0.216***	0.059	0.175**	0.086	0.341***	0.119	0.153	0.136	0.847***	0.311
South	-0.062	0.069	-0.017	0.105	-0.069	0.130	-0.294***	0.151	0.604	0.374
Cons.	-1.770***	0.229	-1.656***	0.349	1.865	1.772	-2.309***	0.568	-15.77*	7.101
Obs	3760		1569		843		1140		208	
Wald chi(2)	220.90	0.000	80.87	0.000	59.52	0.000	85.73	0.000	22.80	0.004

Note: see table 3.

Table A2: Size, market concentration and the probability to invest in R&D. Dependent variable: *RD*. Year 2005

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	-0.159**	0.073	0.437***	0.128	-1.408**	0.631	0.007	0.254	6.751*	3.661
lnCR5sq	0.040**	0.018	-0.040***	0.016	0.271**	0.117	0.010	0.066	-1.042*	0.597
lnsize	0.450***	0.079	0.438***	0.128	0.604***	0.177	0.521***	0.140	0.149	0.297
lnsizesq	-0.038***	0.009	-0.020	0.025	-0.057***	0.020	-0.043***	0.016	-0.003	0.034
lnage	0.429***	0.090	0.479***	0.120	0.872***	0.243	0.227	0.179	-0.552	0.581
lnagesq	-0.048***	0.016	-0.062***	0.022	-0.117***	0.041	-0.012	0.034	0.152	0.109
Centre	0.211***	0.053	0.176***	0.073	0.340***	0.119	0.136	0.120	0.820**	0.312
South	-0.070	0.060	-0.008	0.081	-0.067	0.129	-0.373***	0.145	0.531	0.392
Cons.	-1.626***	0.196	-1.579***	0.281	-0.921	0.962	-1.709***	0.438	-10.99**	5.834
Obs.	4502		2212		855		1227		208	
Wald chi(2)	199.06	0.000	80.47	0.000	61.91	0.000	69.67	0.000	19.36	0.010
					Panel B: CR10					
lnCR10	-0.224**	0.106	-0.017	0.138	-2.250***	0.959	0.037	0.344	8.531*	4.686
lnCR10sq	0.049**	0.023	0.023	0.032	0.372***	0.155	0.001	0.074	-1.201*	0.699
lnsize	0.483***	0.078	0.437***	0.128	0.597***	0.177	0.521***	0.140	0.150	0.297
lnsizesq	-0.042***	0.009	-0.040***	0.016	-0.056***	0.020	-0.043***	0.016	-0.002	0.034
lnage	0.429***	0.090	0.478***	0.120	0.866***	0.243	0.228	0.179	-0.573	0.582
lnagesq	-0.048***	0.017	-0.062***	0.022	-0.116***	0.041	-0.012	0.034	0.157	0.109
Centre	0.210***	0.053	0.176***	0.073	0.334***	0.119	0.136	0.120	0.818***	0.312
South	-0.070	0.060	-0.008	0.081	-0.071	0.129	-0.371***	0.145	0.534	0.388
Cons.	-1.521***	0.216	-1.489***	0.300	-0.672	1.551	-1.740***	0.543	-15.20*	7.834
Obs	4502		2212		855		1227		208	
Wald chi(2)	198.90	0.000	80.28	0.000	62.28	0.000	69.54	0.000	19.80	0.011

Note: see table 3.

Table A3: Size, market concentration and the probability to invest in R&D. Dependent variable: *RD*. Year 2006

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	-0.142***	0.085	-0.165	0.108	-0.999*	0.577	0.046	0.302	6.44*	3.83
lnCR5sq	0.035*	0.021	0.026	0.028	0.194*	0.106	0.006	0.076	-1.04	0.649
lnsize	0.529***	0.076	0.535***	0.123	0.680***	0.172	0.610***	0.135	-0.137	0.333
lnsizesq	-0.045***	0.009	-0.050***	0.015	-0.064***	0.019	-0.050***	0.016	0.029	0.033
lnage	0.452***	0.103	0.532***	0.144	0.824***	0.276	0.205	0.198	-0.639	0.575
lnagesq	-0.052***	0.018	-0.069***	0.026	-0.108***	0.046	-0.006	0.036	0.153	0.106
Centre	0.205***	0.018	0.181**	0.071	0.270***	0.116	0.177	0.120	0.745***	0.293
South	-0.084	0.059	-0.013	0.079	-0.054	0.128	-0.364***	0.146	0.528	0.373
Cons.	-1.87***	0.212	-1.88***	0.301	-1.591	0.923	-1.999***	0.489	-9.251*	5.67
Obs.	4656		2267		876		1266		215	
Wald chi(2)	199.15	0.000	92.17	0.000	59.68	0.000	83.20	0.000	17.84	0.022
					Panel B: CR10					
lnCR10	-0.224*	0.127	0.235	0.164	-1.839*	0.930	0.063	0.431	6.295	4.220
lnCR10sq	0.047*	0.026	0.035	0.036	0.311***	0.152	0.005	0.090	-0.931	0.644
lnsize	0.529***	0.076	0.535***	0.123	0.679***	0.171	0.611***	-0.051	-0.151	0.336
lnsizesq	-0.046***	0.009	-0.05***	0.015	-0.064***	0.0194	-0.051***	0.016	0.031	0.039
lnage	0.452***	0.103	0.531***	0.144	0.826***	0.277	0.205	0.198	-0.560	0.56
lnagesq	-0.052***	0.018	-0.069***	0.025	-0.108***	0.046	-0.006	0.036	0.136	0.103
Centre	0.205***	0.052	0.181***	0.072	0.271***	0.116	0.177	0.120	0.753***	0.292
South	-0.083	0.059	-0.029	0.08	-0.055	0.128	-0.364***	0.146	0.560	0.372
Cons.	-1.752***	0.244	-1.745***	0.335	-0.161	1.502	2.062***	0.648	-9.958	6.879
Obs	4624		2267		876		1266		215	
Wald chi(2)	224.90	0.000	92.11	0.000	60.19	0.000	83.23	0.000	17.18	0.028

Note: see table 3.

Table A4: Size, market concentration and the intensity of R&D investments. Dependent variable: *RDInt*. Year 2004

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	0.022	0.014	0.024	0.019	0.002	0.008	0.001	0.014	0.045	0.112
lnCR5sq	-0.005	0.004	-0.004	0.004	-0.002	0.001	0.001	0.004	-0.006	0018
lnsize	0.049**	0.022	0.043	0.029	0.004	0.002	0.032*	0.018	-0.001	0.001
lnsizesq	-0.003*	0.002	-0.002	0.003	-0.003	0.003	-0.002	0.001	0.001	0.001
lnage	-0.014	0.016	-0.011	0.019	0.002	0.005	0.032	0.034	-0.053	0.50
lnagesq	0.001	0.002	0.0001	0.003	-0.001	0.008	0.005	0.006	0.009	0.009
lnageRD	0.387***	0.053	0.598***	0.112	0.380***	0.001	0.288***	0.015	0.320***	0.02
Centre	0.001	0.007	0.005	0.011	0.001	0.001	0.001	0.007	0.005	0.009
South	-0.008	0.011	-0.011	0.013	0.003	0.002	-0.003	0.008	-0.028	0.029
Cons.	-0.255****	0.098	0.261***	0.115	-0.025	0.017	-0.087**	0.031	-0.043	0.159
Obs.	3760		1569		843		1140		208	
Wald chi(2)	9.87	0.000	4.38	0.000	82229.27	0.000	48.59	0.000	2647.47	0.000
					Panel B: CR10					
lnCR10	0.033	0.021	0.031	0.025	0.003	0.012	0.001	0.020	0.016	0.155
lnCR10sq	-0.007	0.005	-0.005	0.005	-0.001	0.001	0.001	0.020	-0.001	0023
lnsize	0.050**	0.022	0.042	0.029	0.004	0.003	0.032*	0.018	0.001	0.012
lnsizesq	-0.004*	0.002	-0.003	0.003	-0.003	0.003	-0.002	0.002	0.001	0.001
lnage	-0.014	0.016	-0.011	0.019	0.002	0.004	0.032	0.033	-0.053	0.50
lnagesq	0.001	0.002	0.0001	0.003	-0.001	0.008	0.005	0.006	0.009	0.009
lnageRD	0.387***	0.052	0.598***	0.112	0.379***	0.001	0.288***	0.015	0.320***	0.02
Centre	0.001	0.007	0.005	0.011	0.001	0.002	0.001	0.007	0.005	0.009
South	-0.008	0.011	-0.011	0.013	0.003	0.002	-0.003	0.008	-0.028	0.029
Cons.	-0.271***	0.106	0.276***	0.124	-0.027	0.022	-0.087**	0.037	-0.007	0.248
Obs	3760		1569		843		1140		208	
F	9.91	0.000	4.39	0.000	81832.57	0.000	48.68	0.000	2644.47	0.000

Note: see table 3.

Table A5: Size, market concentration and the intensity of R&D investments. Dependent variable: *RDInt*. Year 2005

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	0.020	0.013	0.003	0.004	-0.004	0.035	0.003	0.007	0.015	0.279
lnCR5sq	-0.004	0.003	-0.001	0.001	0.002	0.006	-0.001	0.001	0.003	0045
lnsize	0.067**	0.032	0.006	0.007	0.101*	0.060	0.008	0.005	0.039	0.035
lnsizesq	-0.006*	0.003	-0.001	0.007	-0.011	0.006	-0.001	0.001	-0.003	0.003
lnage	-0.013	0.012	-0.01	0.006	0.063**	0.030	-0.005	0.004	-0.16	0.13
lnagesq	0.0015	0.0019	0.001	0.006	-0.009*	0.004	0.0003	0.0007	0.026	0.021
lnageRD	0.381***	0.061	0.604***	0.022	0.311***	0.037	0.282***	0.014	0.324***	0.10
Centre	0.005	0.006	-0.001	0.001	0011	0.009	0.001	0.003	0.008	0.018
South	-0.005	0.008	0.002	0.003	0.036	0.018	0.001	0.003	-0.066	0.070
Cons.	-0.281***	0.111	-0.060***	0.023	0.401*	0.189	-0.032*	0016	0.030	0.438
Obs.	4502		2212		855		1277		208	
Wald chi(2)	7.21	0.000	95.40	0.000	8.77	0.000	45.99	0.000	203.13	0.000
					Panel B: CR10					
lnCR10	0.026	0.017	0.005	0.006	-0.013	0.005	0.003	0.007	-0.036	0.346
lnCR10sq	-0.005	0.004	-0.001	0.003	0.002	0.008	-0.001	0.001	0.012	0052
lnsize	0.067**	0.033	0.006	0.007	0.101*	0.060	0.008	0.005	0.039	0.035
lnsizesq	-0.006*	0.003	-0.001	0.007	-0.011	0.006	0.001	0.001	0.003	0.003
lnage	-0.013	0.012	-0.001	0.006	0.063**	0.031	-0.001	0.004	-0.16	0.13
lnagesq	0.0015	0.0019	0.001	0.006	-0.009*	0.004	0.001	0.001	0.026	0.021
lnageRD	0.381***	0.061	0.604***	0.022	0.311***	0.037	0.282***	0.014	0.323***	0.10
Centre	0.005	0.006	-0.001	0.001	0011	0.009	0.001	0.003	0.007	0.018
South	-0.005	0.008	0.003	0.004	0.036	0.018	-0.001	0.003	-0.065	0.060
Cons.	-0.292***	0.117	-0.062***	0.024	0.389*	0.196	-0.033*	0017	0.035	0.595
Obs	4502		2212		855		1277		208	
F	7.66	0.000	95.53	0.000	8.80	0.000	46.08	0.000	202.96	0.000

Note: see table 3.

Table A6: Size, market concentration and the intensity of R&D investments. Dependent variable: *RDInt*. Year 2006

Variables	All		Pav1		Pav2		Pav3		Pav4	
	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.	Par.	S.E.
					Panel A: CR5					
lnCR5	0.034	0.026	0.095**	0.045	-0.048***	0.227	0.050	0.039	0.485	0.303
lnCR5sq	-0.010	0.006	-0.027***	0.011	0.008***	0.003	-0.014	0.001	-0.079	0051
lnsize	0.133***	0.028	0.161***	0.060	0.020**	0.009	0.086**	0.041	0.024	0.018
lnsizesq	-0.012***	0.031	-0.015***	0.007	-0.002**	0.001	-0.009**	0.004	0.003	0.001
lnage	-0.164***	0.028	-0.344***	0.051	0.013	0.011	0.003	0.030	-0.079	0.49
lnagesq	0.025***	0.005	0.055***	0.009	-0.004**	0.001	-0.003	0.004	0.01	0.008
lnageRD	0.418***	0.025	0.444***	0.049	0.362***	0.005	0.319***	0.035	0.449***	0.11
Centre	0.040**	0.014	0.022	0.027	0014***	0.005	0.013	0.010	0.007	0.153
South	0.041**	0.019	0.053	0.034	-0.005	0.005	-0.038*	0.021	-0.016	0.017
Cons.	-0.404***	0.074	0.392***	0.142	0.013	0.028	-0.298***	0.108	-0.623	0.450
Obs.	4624		2267		876		1266		215	
Wald chi(2)	36.07	0.000	19.36	0.000	1093.60	0.000	20.10	0.000	242.62	0.000
					Panel B: CR10					
lnCR10	0.060	0.038	0.149	0.068	-0.074***	0.227	0.072	0.055	0.266	0.243
lnCR10sq	-0.013*	0.008	-0.033	0.015	0.011***	0.003	-0.016	0.011	-0.039	0037
lnsize	0.133***	0.028	0.161***	0.060	0.020**	0.009	0.086**	0.041	0.025	0.018
lnsizesq	-0.012***	0.003	-0.015***	0.007	-0.002**	0.001	-0.009**	0.004	0.003	0.001
lnage	-0.164***	0.028	-0.344***	0.051	0.013	0.011	0.003	0.030	-0.075	0.48
lnagesq	0.025***	0.005	0.055***	0.009	-0.004**	0.001	-0.003	0.004	0.01	0.007
lnageRD	0.418***	0.025	0.444***	0.045	0.362***	0.005	0.319***	0.035	0.449***	0.11
Centre	0.040**	0.014	0.022	0.027	0014***	0.005	0.013	0.010	0.007	0.153
South	0.041	0.019	0.021	0.027	-0.005	0.005	-0.038*	0.021	-0.015	0.017
Cons.	-0.441***	0.084	0.475***	0.155	0.038	0.038	-0.338***	0.130	-0.327	0.398
Obs	4624		2267		876		1266		215	
F	36.03	0.000	19.28	0.000	10.78	0.000	20.26	0.000	240.27	0.000

Note: see table 3.