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Ownership structure and R&D: an empirical analysis of Italian listed companies

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1. Introduction

Innovation is the process through which resources are developed to generate a higher quality and/or lower cost product than had previously been available (O'Sullivan, 2000), with the overall objective being to gain or maintain a competitive edge over business rivals. Innovation also affects the firms' ability to penetrate into new markets, including foreign markets. Since the seminal work by Schumpeter (1942), innovation has been recognised as key to economic development and companies' growth. Indeed, a large and influential literature on endogenous growth postulates that firm-level innovation contributes significantly to a country's economic growth and development. Aghion and Howitt (2006) argue that the level of innovation can be explained in terms of entry and exit of markets and the turnover rate of companies. Indeed, they argue that while in the USA 50% of new pharmaceutical products are introduced by companies less than ten years old, in Europe only 10% of this type of product was introduced by firms with a similar age. Moreover, while in the USA 12% of the largest companies in terms of stock market capitalisation are less than 20 years old, in Europe the corresponding figure is only 4%. This phenomenon raises questions concerning the nature of the ownership structure of companies, entrepreneurship and how these issues can affect investment decisions in research and development (R&D). Many prominent scholars have consistently stressed the importance of innovation, and particularly the role of research and development in the growth of companies (e.g.

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Schumpeter, 1942; Yarrow, 1975; Porter, 1992; Zahra and Covin, 1995). Most recently, Harrison *et al*. (2014) found strong empirical evidence that innovation creates employment at firm level, especially thanks to the introduction of new products.

Despite the importance of R&D, from the latest data available from the World Bank it is shown that between 2005 and 2012 Italy spent only 1.27% of its Gross Domestic Product (GDP) on R&D versus the 2.92%, 2.26%, 1.30% and 2.16% of Germany, France, Spain and the Netherlands respectively. Beyond the Anglo-Saxon context, in which the UK and US spend 1.72% and 2.79% of their GDPs on R&D respectively, Japan spends even more on R&D, with a value amounting to 3.39% of its GDP.A recent report by Hernández*et al.* (2014), which analyses the top 2,500 companies worldwide ranked by their investments in research and development, indicates that investments in R&D by companies based in the EU have continued to grow in 2013 in the face of the economic crisis across Europe; however, this growth is below the 2013 world average, and lags behind companies based in the USA and Japan. At the end of 2013, the amount of investment in R&D according to the *EU Industrial R&D Investment Scoreboard* was equal to €538,298 million. Italy invested €8,752.1 million in R&D, 1.63% of total investments. On average, Italian companies invested about €236 million. Among the Eurozone countries, German companies invested a total of €59,47 million; French and Spanish companies invested 28,204.2 and €4,109 million, respectively. This is equivalent percentagewise to 11.5%, 24.5% and 0.76%, of the total expenditure (€538,298 million) by the 2,500 companies surveyed, respectively. The implication of this finding is that EU companies must boost R&D investments to stay globally competitive.

High quality Corporate Governance (CG) is considered an important factor for economic growth and investor confidence, as well as crucial for the development of financial markets (OECD, 2004; Cebula *et al*., 2015; La Porta *et al*., 2002). Morck *et al*. (2002) question the possibility that the allocation of corporate control may be suboptimal in many countries and may adversely affect investment in R&D. In particular, investigating the relationship between the wealth accumulated by the relatives of the founders of the company compared to the GDP of certain countries, they

observe that in those countries where the growth rate is slower than in other similar countries in terms of development, there is a presence of the 'self-made entrepreneur billionaire' with an equal share of wealth compared to the GDP. Morck *et al*. (2002) explain this phenomenon by invoking the concept of a 'creative destruction' of wealth by the heirs of the founder in companies with high ownership concentration, considering that the owners' behaviour is primarily focused on the preservation of accumulated wealth rather than future growth. In other words, since the heirs possess the wealth accumulated by the founder and do not diversify their investments, they could be averse to risk-taking and therefore avoid risky investment projects.

Within this context, the objective of this study is to answer the following question: does ownership structure affect investments in R&D?

Our study is part of the agency theory that has given rise to a broad debate regarding the relationship between optimal ownership structure and firm performance on the one hand, and between ownership structure and optimal investment decisions on the other hand. In recent years in particular, interest regarding this issue and more generally regarding corporate governance, has increased following numerous financial scandals that have taken place in the world, e.g. those at Enron, Lehman Brothers, and WorldCom in the USA, and Parmalat in Italy. Almost every country has enacted legislation, including codes of conduct, in order to properly or at least better regulate the practice of corporate governance.[1]

The principal-agent relationship originated by ownership structure models, which focuses on agency theory, has always represented an interesting discussion arena at both the theoretical (Berle and Means, 1932; Jensen and Meckling, 1976; Demsetz, 1983) and empirical level

[1] The first act of regulation was adopted in the UK with the introduction of the Cadbury Act (1992), subsequently revised as the Combined Code (2003). In 1999, the OECD published *Principles of Corporate Governance*, a document subsequently revised in 2004. In 2002 the Sarbanes-Oxley Act was issued in the USA. In Italy the first code of conduct for listed companies dates back to 1999 (*Codice Preda*), subsequently revised in 2002, 2006 and most recently in 2010 a change was made concerning the subject of directors' remuneration. The last formal review is dated July 2014. For a detailed analysis, we refer to Alvaro *et al*. (2013).

(Demsetz and Lehn, 1985; Morck *et al*., 1988; Demsetz and Villalonga, 2001; Earle *et al*., 2005; Renas and Cebula, 2005; Barontini and Caprio, 2006). The relationship between principal and agent is based on convergence (or divergence) between the interests of owners and those of managers in public companies and on the conflict between majority and minority shareholders in concentrated ownership structures, a widespread model outside the USA and UK (La Porta *et al*., 1999; Faccio and Lang, 2002).

Alongside the classic agency problem that involves managerial entrenchment and expropriation (Berle and Means, 1932; Jensen and Meckling, 1976), another problem can arise when a high ownership concentration prevails and concerns the expropriation of minority shareholders by the controlling shareholders, the so-called 'blockholders', and these issues are called agency problem Type II (Villalonga and Amit, 2006). Some investment decisions are at the heart of the conflict and increase the agency problems. For instance, investments in R&D are investment decisions that may give rise to conflicts between owners and managers, due to different objective functions (Berle and Means, 1932; Jensen and Meckling, 1976).

According to Becker-Blease (2011), innovation means investment in new products and services and more generally in knowledge generation. In his definition, Becker-Blease considers both research and development and patents. It should be noted that the agency costs associated with innovation decisions are likely to be high (Holmstrom, 1989) as corporate managers may be tempted or forced to make suboptimal investment decisions, which may result in either overinvestment or underinvestment. For instance, Francis and Smith (1995) find a positive relationship between ownership concentration and R&D expenses. Shleifer and Vishny (1989), however, believe an active market for takeovers may induce managers to reduce investment in R&D and innovation, as they are difficult to assess.

Generally, managers prefer tangible and low-risk investments and are reluctant to embark upon investment projects that create long-term value; in this way they implement behaviour aimed at underinvestment. This focus on short-term profits is referred to as 'myopic management',

which, according to Porter (1992), caused the declining competitiveness of the USA at the end of the eighties, the same decline that European competitiveness is experiencing today (Brossard *et al*., 2013).

Jensen (1986), however, argued that managers spend the company's cash flow in unprofitable investments, including R&D, to increase their personal compensation and benefits arising from their position, and that such investments do not always turn out to be in the interest of shareholder wealth (overinvestment). He argued that excess cash resources should be distributed to the shareholders and removed from the discretion of managers who tend to reinvest them even in the absence of profitable investment opportunities.[2]

In our opinion overinvestment or underinvestment are two faces of the same coin. In any event, in the light of the foregoing considerations, corporate governance is hypothesised to impact firm innovation and consequently economic growth. Within the literature dealing with the impact of CG on firm innovation, there is a stream of analysis that addresses the relationship between ownership structures and innovation; however, the related empirical research is still in its relative infancy with most contributions focused on the US context.

Using a balanced panel data of 369 firm-year observations we examine the relationship between the ownership structure and investment in R&D of a sample of Italian listed companies during the period 2005-2013.

Our study extends the previous literature in several ways. First, it examines the relationship between ownership structure and R&D by considering the ownership concentration, as measured by the share of the first top three shareholders, the presence of institutional investors and the

[2] Murgia (1993) examines a sample of Italian listed companies during the period 1983-1990 and confirms the thesis of Jensen (1986). In particular, he finds a negative relationship between the pay-out and the share control of the dominant shareholder when the company produces free cash flow. On the contrary, when the company generates a modest cash flow the sign of the relationship is positive. He concludes that the use of dividend policy, under conditions of scarce financial resources, can have goals that conflict with the objective of maximising the value of the company.

shares owned by the board of directors. Institutional investors[3] are important figures because, in theory, they should not pursue short-term yield policies, but rather they should invest in projects with a prospect of enhancing medium and long-term yields. It is no wonder that they are called 'patient investors' because they may guarantee greater activism with regard to innovation policies and push managers towards higher risk investments, such as R&D, and towards being growth-oriented with a medium/long term vision. In other words, institutional investors could play an effective role in monitoring, especially in countries like Italy, where the high ownership concentration tends to increase the private benefits of control at the expense of minority shareholders (Bigelli and Mengoli, 2004). The data contained in the latest CONSOB report (2014) reveal that in Italy the presence of institutional investors is still marginal. On average, 15.3% of the share capital of listed companies is held by Italian and foreign institutional investors. However, Italian institutional investors own a minimal share (on average, about 0.9%), and in over half of the listed companies in the sample surveyed by CONSOB there is literally no detectable presence of institutional investors.

Second, our study fits into the context of agency theory, considering R&D as an element of convergence (or divergence) between the interests of majority shareholders and minority shareholders and as a proxy for risk-taking. Since the Italian context is of particular interest with regard to ownership concentration, in this study we indirectly examine the hypothesis that risky investments are avoided by the largest shareholders, at the expense of minority shareholder interests. In other words, the ownership concentration and the prevalence of the family business model could reduce the investment in R&D: on the one hand, because most of the shareholder's wealth is invested in the company, and this allows the assumption that the owners hold undiversified portfolios, possibly

[3] In this study institutional investors are understood as Italian and foreign mutual investment funds, operators of private equity, venture capital, and banks and insurance companies. In the sample examined, we found an average institutional investor ownership stake ranging from 18.2% in 2005 to 3.39% in 2013. A comparison of the period 2005-2008 to the period 2009-2013 shows that on average the equity held by institutional investors increased from 3.24% to 4.21%, respectively, of the share capital of the companies investigated.

implying increased risk aversion, and on the other hand because board members are related, directly or indirectly, to the ownership and therefore may be influenced by the controlling shareholders.

Third, our analysis covers a period of nine years and includes both the pre-financial crisis period (2005-2007) and the period during the financial crisis (2008-2010) as well as the recession phase (2011-2013); this diverse composition within the study sample could boost the consistency and reliability of findings regarding the relationship between ownership structures and R&D outlay practices.

2. Literature review and hypothesis development

R&D is an important source for the growth of businesses and GDP (Cebula *et al*., 2015), and to ensure an adequate level of competitiveness amidst the new situations that have taken shape as a result of globalisation and the introduction of new information and communication technologies (ICT). R&D can be investigated from a variety of perspectives, including that of agency theory. In the agency theory context, R&D takes on a different meaning since it represents a discordant element between managers and shareholders operating in traditional Anglo-Saxon systems, and between majority shareholders and minority shareholders in countries with a high ownership concentration such as Italy. As it is commonly understood in the literature on the subject, investments in innovation are risky, involve a long time horizon and uncertain returns, and are subject to both information asymmetry and moral hazard. Shareholders may be interested in investing in R&D, having a long-term view and a stake in maximising value, while managers may have a different time perspective and look only for short-term results. In Italy, in particular, the share of capital held by majority shareholders reaches, or exceeds, 50%, and therefore they could be risk-averse since they hold undiversified portfolios.

Given such conditions, innovation decisions are investment decisions that may give rise to shareholder-manager conflicts (Holmstrom, 1989). On the one hand, shareholders cannot properly

evaluate investments in a long-term project either because they lack technical and scientific skills or because companies decline to fully reveal the information necessary to assess the real value of innovation; on the other hand, managers may prefer lower-risk strategies with low-variance returns, due to concerns about the impact of innovation failure on their careers, which might result in under-investment in R&D and innovation (Shleifer and Vishny, 1989).

In the related literature there are two main views on what spurs or deters innovation. The first one is that firms innovate more when managers are insulated from takeover pressures (Stein, 1988), based on the contention that the threat of takeover encourages myopic behaviour (i.e. a short-term focus) on the side of managers. The opposite view is that CG systems which insulate managers from external or firm-level disciplinary mechanisms lead them to reduce innovation efforts, shirk them or even be content with a 'quiet life' (see in particular Hart, 1983; Bertrand and Mullainathan, 2003).

Many empirical studies have been conducted to test these alternative predictions, through exploring how innovation is affected by either internal mechanisms (e.g. manager compensation contracts, monitoring by institutional investors and firm-level anti-takeover provisions), or external mechanisms such as state-level anti-takeover provisions or product market competition. Thus, for instance, Meulbroek *et al*. (1990) documented empirically that R&D intensity in firms decreases following the implementation of anti-takeover amendments. By contrast, Becker-Blease (2011) found that higher levels of anti-takeover provisions (as measured by the G-index) are positively associated with four measures of innovation, namely R&D expenditures, awarded patents, the quality of patents awarded and the number of patents awarded per dollar of R&D investment. In particular, they reported firm-level provisions to be more important (significant) than state-level provisions in this positive association.

Chemmanur and Tian (2013) have shown that firms that adopt a larger number of anti-takeover provisions innovate more. They have also found anti-takeover provisions to impact favourably on firm value (as measured by Tobin's *q*) but only for firms involved in intensive innovation activities. A strand of literature has looked at the effect of long-term incentive contracts

on innovation (Lerner and Wulf, 2007; Manso, 2011). Bianchini *et al*. (2015) empirically explored the relationship between CG, innovation and firm age on a sample of non-US firms operating in 24 countries and 21 industries, reporting that CG has a negative relationship with innovation (as measured by R&D expenditures and the number of patents), which is stronger for younger firms than for mature ones.

Another research strand has dealt with the impact of firms' ownership structure on innovation; however, the related empirical literature is still limited and mostly focuses on the US context. For instance, Francis and Smith (1995) have explored empirically the relationship between corporate ownership structure and innovation, testing the hypothesis that diffusely held firms were less innovative than firms with either a high concentration of management ownership or a significant equity block held by an outside investor. Overall, their findings indicate that diffusely held firms are less innovative along the dimensions of patent activity, growth by acquisition versus internal development and timing of long-term investment spending. As such, they lend support to the view that concentrated ownership and shareholder monitoring are effective at alleviating the high agency costs associated with innovation. Interestingly enough, Francis and Smith (1995) use different types of management-owned models, including the 'CEO-held' model, in which the ownership of the chairman of the board (CEO) and his family is equal to at least 30% of the voting shares; the case in which the corporation has a broad shareholder base and the board holds less than 15%; the 'insider-held' model, in which ownership of the CEO and his family is less than 5% of the shares with voting rights and the management holds at least 20%; and finally the 'outsider-held' model, in which the CEO and his family own less than 5% and outsider (non-management) investors own at least 20% of the shares with voting rights. Moreover, they use different measures of innovation, i.e. they consider both investments in R&D for patents and the output resulting from innovation. While they always find a positive and statistically significant relationship between the number of patents and the three ownership models, they find a negative relationship between the first model, in which the ownership of the chairman of the board (CEO) and his family

is equal to at least to 30% of shares with voting rights, and the expenditure on R&D for patents. Ultimately, an analysis of their results shows that if it is true that companies with greater ownership concentration increase the total number of patents, it is also true that the relationship between ownership concentration and expenditure on R&D for patents is negative and statistically significant. In addition, they also find that companies with a broad shareholder base spend more on R&D as compared to more concentrated firms. Our analysis, with all the appropriate limitations included and given that it was conducted in Italy, a country with high ownership concentration, is partly comparable to their analysis relative to the first model, in which the CEO and his family hold at least 30% of the shares with voting rights.

Bushee (1998) uncovered evidence that managers are less likely to cut R&D to reverse a decline in earnings when institutional ownership is high. Eng and Shackell (2001) found evidence that holdings by institutional investors are positively associated with R&D expenditures. However, other studies indicate a negative relationship between innovation activities (R&D projects) and institutional investors, as they would look more at short-term performance (Graves and Waddock, 1990). More recently Aghion *et al*. (2013), using a sample of US publicly-traded firms, reported that institutional ownership boosts innovation especially where product market competition is higher and managers are less entrenched (that is, less protected from hostile takeovers). Brossard *et al*. (2013) tested the relationship between ownership structures and firms' innovation activity (in terms of R&D spending) in Europe using a large sample of highly innovative European companies. They show that firms have higher R&D ratios when their ownership is dominated by institutional investors but lower R&D ratios when impatient institutional investors (i.e. investors seeking short-term profits) dominate ownership.

Eventually Minetti *et al*. (2012) explored the impact of ownership structures on innovation using a rich data set of about 20,000 Italian manufacturers. They found that ownership concentration negatively affects firm innovation, especially by reducing firms' R&D efforts. Interestingly, they also found some evidence that family ownership

supports innovation more than financial institutions, but also that the benefits of ownership by financial institutions for firms' innovation increase with their equity stakes. Collectively, their findings contrast with what is predicted by the US-based literature, suggesting that the agency problems that affect innovative firms in the USA differ from those affecting firms in other countries, due to the circumstance that managerial agency problems that characterise US public companies can substantially differ from those plaguing businesses in Europe and Asia.

Since the ownership structure of firms constitutes one major dimension of corporate governance, this study focuses on the relationship between ownership structures and corporate innovation activity as measured by R&D. Moreover, our analysis is performed on the Italian business context that provides an interesting environment to explore the impact of ownership concentration on innovation, in that it is heavily characterised by the presence of individual owners who hold sizeable equity stakes in companies, while institutional investors are less widespread than in the USA. In addition, we believe that Italy is suitable for this kind of empirical investigation because of the particular composition of companies' boards of directors, whose members are directly or indirectly linked to owners and show a still limited presence of multicultural diversity in the boardroom (e.g. in terms of gender, nationality, etc.).

In countries where the level of ownership concentration is high, agency problems do not arise between shareholders and managers but between majority and minority shareholders. The conflict could transfer the entrenchment effect to controlling shareholders and have a negative impact on spending in R&D. Morck *et al.* (2002), for example, found that in Canada the heir-controlled firms invest less in R&D, as opposed to widely-held companies or those controlled by the founding owners. They argue that the controlling shareholders have accumulated their wealth and that innovation would destroy their capital through 'creative destruction'. Basically, heirs tend to preserve the accumulation of capital and the status quo. Therefore, in countries where ownership concentration is high and in the presence of an entrenchment effect, there could be a negative relationship between ownership structures and R&D investments, as

shown in empirical studies (Di Vito *et al*., 2010; Czarnitzki and Kraft, 2009; Munari *et al*., 2010).

A high ownership concentration and the presence of a family business model could limit the implementation of risky investment projects. Most of the family wealth is invested in the company and therefore it may occur that the equity portfolio is poorly diversified and this would increase the ownership's risk aversion to invest in riskier projects (John *et al*., 2008; Faccio *et al*., 2011). For instance, Boubaker *et al*. (2012) investigated 525 French listed companies during the period 2003-2007 and found a negative relationship between large controlling shareholders and corporate risk-taking. On the contrary, they note that when the number and power of multiple shareholders increase, there is an increase in risk-taking. Multiple shareholders counterbalance the conservative approach of controlling shareholders as they play a monitoring role. Board ownership, whose shareholding is in the hands of family members, could also discourage R&D investment.

For all the reasons stated above, in this paper we formulate the following hypotheses:

Hypothesis 1 (*H1*): *There is a negative relationship between R&D and ownership concentration*;

Hypothesis 2 (*H2*): *There is a negative relationship between R&D and board ownership.*

Finally, while Graves and Waddock (1990) found that the presence of institutional investors is negatively associated with investment in innovation, and in particular with projects in R&D, Bushee (1998), Eng and Shackell (2001) and Aghion *et al*. (2013) found a positive relationship between the presence of institutional investors and investment in R&D. Given the ownership structure in Italian companies, we believe that the presence of institutional investors can be of added value in investment decisions in R&D. Therefore, we formulate the last hypothesis:

Hypothesis 3 (*H3*): *The presence of institutional investors encourages investment in R&D.*

3. Data and survey methodology

This investigation is based on a balanced data panel of Italian listed companies observed during the period 2005-2013. It explores, using both fixed effects, as suggested by the Hausman test (1978), and dynamic panel data including system GMM, the relationship between ownership structure and R&D on 369 firm-year observations on the Italian stock market. The companies belonging to the sample had to meet the following requirements:

a) the availability of data regarding R&D, which were acquired through the *EU Industrial R&D Investment Scoreboard* (2005-2014) of the European Commission (Hernández *et al.*, 2014). This annual ranking of the top 1,000 (or 2,500) European companies investing in R&D accounts for a very large part of European R&D;

b) the availability of financial data and corporate governance indicators during the entire observation period, which were acquired through Datastream, the Calepino dell'azionista (Mediobanca), Bloomberg, the reports on corporate governance and the financial statements of the individual companies, and finally the CONSOB websites.

The sample investigated consists of 41 companies for a total of 369 firm-year observations and accounts for more than 50% of the total market capitalisation at the end of 2013. The sample consists primarily of manufacturing enterprises along with a few service enterprises and excludes all financial firms (SIC code 6000 to 6999). By examining the sample, it is observed that in five companies the majority shareholder is the state, which controls the company through the Ministry of Economy and Finance; in all other cases, the companies are controlled directly or indirectly by family groups, which use trust companies, holding companies and non-listed companies. In the period studied, the average (median) percentage of shares held by the largest shareholder amounted to 56.32% (59.98%), and in most cases the controlling shareholder is a legal entity.

In the following sections, we develop the research methods and perform the statistical analysis, designed specifically for our unique panel data based on both econometric techniques and research objectives. In the first step, we construct base-line ordinary least square (OLS) model. The

following equation reflects the model specification:

$$y_{i,t} = \mu + \alpha_1 \cdot OWN\_Structure_{i,t} + \alpha_2 \cdot Control\_Variables_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ is the dependent variable, expressed as log(R&D), i.e. the logarithm of the amount of expenses for research and development; μ is a constant; and α is the coefficient.

In this study we measure the ownership structure by using different indicators. The first is the sum of the percentage of shares held by the top three largest shareholders (*OC3*). The second is a binary dummy variable that takes on a value of 1 if one shareholder held more than 50% of the shares, and 0 otherwise (*DUMMY_50*). The third indicator is a binary variable too, a dummy variable that takes on value 1 if at least one shareholder is an institutional investor, and 0 otherwise (*INST_INVESTORS*). The fourth indicator measures the percentage of shares owned by members of the Board of Directors (*B_OWN*). Lastly, we include a dummy variable that takes on a value of 1 if at least one director owns shares, and 0 otherwise (*D_BOWN*).

As control variables we use the size of the enterprise, measured by the logarithm of total assets (*LOG SIZE*), the debt-to-capital ratio (*Debt ratio*), the logarithm of firm age, considering as the first year the establishment of the firm (*LOG Firm_AGE*), and the industrial sector (*Industry*), excluding all companies belonging to the financial sector (four-digit SIC code 6000-6999). In addition, as a moderating effect we separately examine the interaction of a number of variables, including the multiplication between the shares of the first and second shareholders (*1SH · 2SH*), the multiplication between the shares of the second and third shareholders (*2SH · 3SH*), between the first and third shareholders (*1SH · 3SH*), and between the top three shareholders (*1SH · 2SH · 3SH*). We also use the interaction between *OC3 · D_INST* and *BOWN · D_INST* to verify whether the two variables (*OC3* and *BOWN*) change their signs when they interact with the institutional investors' variable.

Table 1 presents a list of the variables used in this study, their measurement and their source.

Table 1 – *Variables defined*

Variables	Measurement	Source
R&D	Log of Research and Development	Scoreboard of the Top EU companies
Debt-to-capital ratio (LEVERAGE)	Total debt scaled by total assets	Bloomberg, Datastream and hand collection from *Calepino dell'azionista*
Firm SIZE	Log Total assets	Bloomberg, Datastream and hand collection from *Calepino dell'azionista*
OC3	Top 3 largest shareholders	Hand collection from CONSOB and Corporate Governance Reports
B_OWN	% of shares owned by Board of Directors	Hand collection from Corporate Governance Reports
D_BOWN	Dummy = 1 if board held % shares; 0 otherwise	Our calculation
Industry	Four-Digit SIC (Standard Industrial Classification) codes	Italian National Institute of Statistics
Firm AGE	Log years by firm establishment	Firms' websites
INST_INVESTORS (D_INST)	Dummy = 1 if present; 0 otherwise	Hand collection from Corporate Governance Reports and CONSOB
DUMMY_50	Dummy = 1 if majority shareholder held more than 50 percent; 0 otherwise	Our calculation

Table 2 provides descriptive statistics of the variables used in this study. The average investments in R&D amounted to 203.28 million euros, with a median value of 35 million euros. The average total assets of the sample are equal to €36,738.21 mln, with a median value of €1,618.9 mln. The average age of the company, starting from its inception, is equal to 60.2 years (median 52) with a range that varies from

8 to 177 years. *B_OWN* varies between 0% and 71.08%. On average (median) the board holds 9.94% (0%) of the shares of the companies investigated.

Comparing the pre-crisis period/start of the crisis period (2005-2008) to the following period (2009-2013), which is characterised by the crisis and its recession, we observe certain differences for all the variables examined. Regarding R&D in 2005-2008, the sample firms spend less on average (€130.68, mln) compared to the following period 2009-2013 (€176.9 mln). The share ownership held by the top three largest shareholders varies marginally. By comparing the two periods, in fact, we find an increase of 5% between 2005-2008 and 2009-2013. The debt level also seems to vary when the two periods are compared: in the period 2009-2013, the debt-to-capital ratio increases by 5.63%. However, by applying the test on the averages for each variable, no statistically significant difference can be inferred between the pre-crisis period and the start of the crisis (2005-2008) and the crisis period and its accompanying recession phase (2009-2013).[4]

4. Results and discussion

Table 3 shows the fixed effects results. We find a negative and statistically significant relationship between ownership structure, as measured by *OC3*, *B_OWN* and *DUMMY_50*, and *D_BOWN*, whereas the relationship between *INST_INVESTORS* and R&D is, except for model 1, in all cases positive and statistically significant.

[4] We perform a comprehensive diagnostic check of multicollinearity through variance inflation factors (VIF). We find that none of the models in this study have strong multicollinearity problems (VIF_{max} is 1.91). We also perform the Hausman test (1978) to choose the most appropriate model and in addition, we adopt the dynamic panel data including system GMM for robustness testing to address any endogeneity problem as raised by Demsetz and Lehn (1985).

Table 2 – *Descriptive statistics of variables*

Variables	Obs.	Average	Median	S.D.	Min	Max	Means difference (*t*-value)
Dependent Variables							
R&D (million euros)	369	203.28	35	591.67	2.4	3,362	–45.27 (0.48)
Log_R&D	369	1.52	1.4	0.67	0	3.52	–0.17 (1.23)
Independent Variables							
OC3 (%)	369	56.32	59.58	24.71	0	100	–0.05 (1.04)
DUMMY_50	369	0.53	1	0.5	0	1	–0.00 (0.09)
B_OWN (%)	369	9.94	0	19.8	0	71.08	–0.00 (0.00)
D_BOWN	369	0.31	0	0.46	0	1	–0.03 (0.3)
INST_INVESTORS	369	0.51	1	0.5	0	1	–0.07 (0.89)
Control Variables							
FIRM AGE	369	60.2	52	42.88	8	177	
Debt ratio (LEVERAGE)	369	36.18	33.2	23.16	0	97.17	–5.63 (1.28)
SIZE	369	52,612.35	1,618.9	160,026.61	51.53	827,217.57	–34,574 (0.28)
LOGSIZE	369	3.44	3.23	1.27	0	6.67	–0.1 (0.39)
INDUSTRY	YES						

Note: the value of the means difference has been obtained by calculating the difference between the average of the variables (2005-2008) – (2009-2013).

The board ownership shows negative and statistically significant values in all models. Also, the variables used as a moderating effect, i.e. the interaction between the individual shareholders, always appear negative but only the variable of interaction between the first and the second shareholder (*1SH · 2SH*) is statistically significant. Both the age and the size of the company appear always positive and statistically significant in all models. The debt variable, instead, appears always negative and also statistically significant, except in model 7.

To further address any possible endogeneity issues, we also use a dynamic panel data approach that includes a system GMM (generalised method of moments) with all the variables lagged one year (Anderson and Hsiao, 1981; Arellano and Bond, 1991; Blundell and Bond, 1998) in order to measure the deviations from the fixed effects model (table 4). The GMM method is known to be more robust in dealing with endogeneity problems, which can arise in this type of analysis (Wintoki *et al*., 2012). In table 4 we illustrate the results obtained using the GMM model with all independent variables lagged one year.

The signs of the variables are also confirmed in this second analysis. The relationship between ownership concentration and R&D is always negative and statistically significant. In this case as well, the board ownership shows negative and statistically significant values in all models. Even the signs of the interaction coefficients (*1SH · 2SH · 3SH*), (*1SH · 2SH*), (*1SH · 3SH*) and (*2SH · 3SH*) are always negative and almost always statistically significant. Both the size and firm age variable confirm the signs. Finally, we have a confirmation for a negative sign for the coefficient debt-to-capital ratio. Table 5 illustrates the fixed effects and GMM model results.

The values are in line with those obtained in previous analyses. The relationship between ownership concentration and spending on R&D remains negative and statistically significant for all the variables used. We also find a negative relationship between the board ownership. However, when we introduce the interaction terms, the coefficients are always positive and statistically significant for *OC3 · D_INST*, while

Table 3 – *Fixed effects model with R&D as dependent variable*

	1	2	3	4	5	6	7
Constant	0.188	0.299**	0.254*	0.097	0.153	0.147	0.101
	(0.151)	(0.147)	(0.145)	(0.134)	(0.147)	(0.148)	(0.131)
OC3	–0.764***	–0.838***					
	(0.14)	(0.132)					
OC3 squared							–0.823***
							(0.126)
B_OWN	–0.005***						
	(0.001)						
D_INST	0.067	0.108**	0.102**	0.144***	0.157***	0.150***	0.084*
	(0.05)	(0.049)	(0.049)	(0.05)	(0.05)	(0.051)	(0.049)
D_BOWN		–0.369***	–0.413***	–0.343***	–0.364***	–0.364***	–0.400***
		(0.057)	(0.064)	(0.058)	(0.06)	(0.061)	(0.058)
DUMMY_50			–0.325***				
			(0.058)				
Moderating effects							
1SH·2SH				–3.541***			
				(0.362)			
1SH·3SH					–1.78		
					(1.269)		
2SH·3SH						–3.749	
						(3.147)	
FIRM AGE	0.453***	0.479***	0.391***	0.362***	0.313***	0.311***	0.5***
	(0.062)	(0.057)	(0.061)	(0.052)	(0.056)	(0.056)	(0.055)
LEVERAGE	–0.222**	–0.255**	–0.435***	–0.435***	–0.617***	–0.620***	–0.142
	(0.102)	(0.106)	(0.103)	(0.095)	(0.111)	(0.111)	(0.117)
FIRM SIZE	0.332***	0.31***	0.299***	0.339***	0.343***	0.345***	0.305***
	(0.029)	(0.028)	(0.03)	(0.028)	(0.028)	(0.028)	(0.027)
INDUSTRY	YES	YES	YES	YES	YES	YES	YES

(*continued*)

(*continues*)

R-square	0.534	0.564	0.545	0.532	0.503	0.503	0.568
Adj. *R*-square	0.466	0.500	0.478	0.464	0.431	0.431	0.505
F-value	7.82***	8.85****	8.19***	7.78***	6.94***	6.93***	8.99***
χ^2	22.04***	25.71***	18.76***	31.30***	20.92***	20.43***	24.91***
Wald test	1453.42***	761.04***	648.73***	687.79***	480.08***	489.01***	761.19***
VIF_{MAX}	1.57	1.55	1.49	1.43	1.38	1.36	1.68
N. Obs.	369	369	369	369	369	369	369

Note: (*), (**) and (***) indicate significance levels of 10%, 5% and 1% respectively. VIF = Variance Inflation Factor. Standard errors are given in brackets.

Table 4 – *Dynamic panel data including system GMM with R&D as dependent variable and independent variables lagged one year*

	1	2	3	4	5	6	7	8
Constant	0.311**	0.275*	0.32*	0.231	0.283***	0.221	0.253	0.246
	(0.144)	(0.156)	(0.167)	(0.165)	(0.14)	(0.15)	(0.15)	(0.162)
LOG $R\&D_{t-1}$	0.446***	0.458***	0.424***	0.452***	0.489***	0.479***	0.458***	0.437***
	(0.146)	(0.147)	(0.133)	(0.153)	(0.158)	(0.141)	(0.15)	(0.147)
OC3	–0.331*							
	(0.173)							
B_OWN		–0.003***						
		(0.001)						
D_INST			0.004					
			(0.037)					
D_BOWN				–0.187***				
				(0.054)				
DUMMY_50					–0.134*			
					(0.08)			
Moderated effects								
1SH·2SH·3SH	–1.969	–5.896*	–4.246	–9.089*	–10.48**			
	(5.846)	(3.087)	(3.194)	(3.986)	(4.25)			
1SH·2SH						–1.189*		
						(0.66)		
1SH·3SH							–2.118**	
							(0.861)	
2SH·3SH								–5.752*
								(3.102)

(*continued*)

(*continues*)

FIRM AGE	0.177*	0.128	0.144*	0.121	0.135	0.126	0.118	0.124
	(0.107)	(0.089)	(0.086)	(0.092)	(0.093)	(0.089)	(0.089)	(0.09)
LEVERAGE	–0.002**	–0.004***	–0.004***	–0.003***	–0.002**	–0.003**	–0.003***	–0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
FIRM SIZE	0.16***	0.162***	0.166***	0.167***	0.142***	0.157***	0.165***	0.173***
	(0.041)	(0.048)	(0.046)	(0.05)	(0.044)	(0.048)	(0.05)	(0.05)
INDUSTRY	NO	NO	NO	NO	NO	NO	NO	NO
AR (1)	–3.231***	–3.038***	–3.126***	–3.011***	–3.058***	–3.075***	–3.028***	–3.06***
AR (2)	1.609	1.505	1.444	1.555	1.785*	1.635	1.535	1.548
Sargan	59.29	63.67	54.30	58.98	69.72	66.08	60.05	56.06
Wald test	123.69***	132.47***	129.54***	90.32***	126.65***	114.76***	90.52***	85.2***
χ^2	10.11***	9.36***	8.92**	6.25**	9.71***	8.5**	6.68**	5.46*
N. Obs.	328	328	328	328	328	328	328	328

Note: (*), (**) and (***) indicate significance levels of 10%, 5% and 1% respectively. VIF = Variance Inflation Factor. Standard errors are given in brackets.

Table 5 – *Fixed effects and GMM models with R&D as dependent variable*

	1	2	3	4
Constant	0.17	0.055	0.294**	0.274***
	(0.148)	(0.075)	(0.148)	(0.056)
OC3	–0.861***	–0.835***	–0.905***	–0.904***
	(0.146)	(0.07)	(0.135)	(0.061)
BOWN			–0.339***	–0.461***
			(0.066)	(0.029)
Moderating effects				
OC3•D_INST	0.254***	0.221***	0.216**	0.227***
	(0.094)	(0.053)	(0.091)	(0.044)
BOWN•D_INST	–0.006***	–0.007***	–0.001	–0.000
	(0.001)	(0.000)	(0.001)	(0.000)
$R\&D_{t-1}$		0.045***		0.096***
		(0.01)		(0.016)
FIRM AGE	0.457***	0.479***	0.484***	0.475***
	(0.061)	(0.029)	(0.058)	(0.032)
LEVERAGE	-0.164	-0.280***	-0.236**	-0.317***
	(0.108)	(0.057)	(0.107)	(0.051)
FIRM SIZE	0.343***	0.358***	0.318***	0.315***
	(0.028)	(0.01)	(0.028)	(0.007)
INDUSTRY	YES	YES	YES	YES
R-square	0.534		0.565	
Adj. *R*-square	0.465		0.5	
F-value	7.82***		8.67***	
AR (1)		–4.53***		–4.12***
AR (2)		–1.37		0.411
Sargan test		39.93		36.54
χ^2	18.47***	12.83***	25.48***	14.35***
Walt test	1398.41***	12347.3***	766.7***	8382.37***
VIF_{MAX}	1.38	1.38	1.91	1.91
N. Obs.	369	369	369	369

Note: (*), (**) and (***) indicate significance levels of 10%, 5% and 1% respectively. VIF = Variance Inflation Factor. Standard errors are given in brackets. Columns 1 and 3 show the results of the fixed effects model. Columns 2 and 4 show the results of the GMM model.

they are always negative and in two cases also statistically significant for *BOWN · D_INST*. This could mean that the presence of institutional investors is effective, especially at high levels of ownership concentration. In such cases, institutional investors could play their monitoring role effectively by encouraging greater investments in R&D.

Both the size and firm age variable confirm the sign of the previous analyses. We find that the relationship between debt-to-capital ratio and R&D is always negative, as in previous analyses, but it is also significant in all models tested, except in model 1.

Ownership concentration seems to hold back investments in R&D, as well as the board's participation in the risk capital of the firms examined. The explanation for the negative relationship between board ownership and R&D could derive from the fact that the board members who possess shares are almost always the owners of the firm as well. In the Italian scenario, in fact, the members of the board often belong to the family that runs the firm.

The first conclusion that one might draw is that the ownership concentration affects R&D expenditure negatively. From an agency-theory perspective, the underinvestment phenomenon seems to emerge, which would lend support to the hypothesis of the expropriation of minority shareholders by controlling shareholders. Essentially, the latter appear to be risk and innovation adverse. These findings are consistent with other studies (Minetti *et al*., 2012; Morck *et al.*, 2002; Di Vito *et al*., 2010; Czarnitzki and Kraft, 2009 and Munari *et al*., 2010), whereas the positive value recorded by the dummy variable of institutional investors could be consistent with the results of other studies (Brossard *et al*., 2013; Eng and Shackell, 2001 and Aghion *et al*., 2013). Arguably, institutional investors are typically supportive of greater R&D outlays when the ownership is concentrated.

Finally, out of all the hypotheses tested, we found confirmation for hypotheses H1, H2 and H3. Our analysis also revealed a positive and statistically significant link between R&D expenditures, firm size and firm age. Of particular interest is the negative relationship revealed between R&D and the debt coefficient; this result may portend the entrenchment effect and be in line with the view of Jensen (1986),

according to which managers use free cash flow to finance risky investments at the expense of the distribution of dividends to shareholders. If this were true, that claim cannot be sustained in this work and must be left to future investigations, it would mean that the investment processes are not carried out in order to create value for the company but only to increase the private benefits of control by majority shareholders, and this aspect increases agency problems of type II (Villalonga and Amit, 2006).

5. Conclusions

This study has investigated the relationship between R&D outlays by public corporations and ownership structure using a sample of 369 firm-year observations over the period 2005-2013. Our findings indicate a negative relationship between R&D outlays and ownership concentration. In fact, by exploring the link between the ownership stakes held by the three largest shareholders and R&D, we found a negatively signed relationship that appears consistent with the predictions of the entrenchment theory. In the presence of family capitalism and high ownership concentration, one might interpret this negative relationship as a manifestation of risk-aversion on the part of controlling shareholders and an expropriation of minority shareholders. In business environments like Italy, one might advance two hypotheses. The first is that with a larger stake held by firm owners the possibility to keep diversified portfolios is lowered, and as a result the tendency is to implement a 'conservative' strategy, avoiding risky investments with uncertain payoffs. The second hypothesis is that ownership concentration induces some kind of entrenchment behaviour on the part of controlling shareholders. Since the latter have no need to monitor managers with the control being in their hands, they do not necessarily pursue strategies aimed at long-term value creation. Additionally, it should be considered that the board of directors is strongly influenced by the corporate owners.

Another point of interest is the finding of a positive relationship between R&D spending and institutional investors. Also noteworthy is

the relationship between R&D spending, firm age and firm size, and equally interesting is the negative relationship between investment in R&D and the debt-to-capital ratio. This might suggest that such investments are financed with cash, in line with the view espoused by Jensen (1986).

Our study makes a contribution to the previous literature but is of course not free from limitations. Future research should, on the one hand, be extended to a greater number of observations, and on the other hand should investigate the relationship between R&D investment and ownership structure in a broader geographical context. Therefore, further investigation is necessary to lend support to our hypotheses and contentions.

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