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INSTITUTIONAL FRAMEWORK, CORPORATE OWNERSHIP STRUCTURE, AND R&D INVESTMENT: AN INTERNATIONAL ANALYSIS

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INSTITUTIONAL FRAMEWORK, CORPORATE OWNERSHIP STRUCTURE, AND R&D INVESTMENT: AN INTERNATIONAL ANALYSIS*

We combine agency theory with the law and finance approach to analyze how the legal protection of investors and the corporate ownership structure affect the corporate investment in research and development (R&D). We use information from 1,091 firms from the five most R&D intensive industries in 19 developed countries. Our results show that the better protection of investors' rights by the institutional environment has a positive influence on corporate R&D. We also find that corporate ownership concentration works as a substitute for legal protection. This finding means that the R&D investment of the firms in the countries with poor legal protection increases as long as the ownership becomes more concentrated. Our results also show that the identity of shareholders has a relevant effect: Whereas banks and nonfinancial institutions as shareholders result in lower R&D, institutional investors as shareholders increase the corporate investment in R&D.

Key words: Institutional setting, ownership structure, corporate R&D, legal protection.

Classification JEL: G32, O32

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1. Introduction

The European Commission (2014) has recently launched the latest edition of the Innovation Union Scoreboard, which provides a comparative assessment of the innovation performance of the 28 member states of the European Union (EU). Based on their innovation performance across 25 indicators, the countries fall into four groups: innovation leaders, innovation followers, moderate innovators, and modest innovators. The report shows that the four countries within the leaders group (Denmark, Finland, Germany, and Sweden) have certain common characteristics. Namely, these four leaders display above average research and development (R&D) in the business sector and strong partnerships between public and private sectors, which suggests a collaborative relation between the national science system and the applied industry.

The recent financial crisis has resulted in tightening financial constraints to public expenditure in R&D (Archibugi et al., 2013; Muscio et al., 2013; Xu et al., 2014). Thus, to maintain the level of expenditure in R&D, policy makers and practitioners struggle to find new ways to improve the collaboration between the State and firms (Barker et al., 2012). In other words, as shown by the innovation leader countries, the current economic situation challenges states to provide the conditions necessary for firms to develop a more active role in R&D (Escribá-Esteve & Montoro-Sánchez, 2012). Given the shortage of public funds for R&D, these new solutions are likely to include structural reforms to provide innovative firms with the appropriate incentives and legal protection.

Whereas the need for financial support for R&D activities has been the focus of considerable research (Brown et al., 2009; Cappelen et al., 2012; Driver & Guedes, 2012; Festel, 2014; Pastor-Agustín et al., 2011), the previously mentioned financial constraints have introduced a dramatic change in the scenario. This study combines a financial and an institutional approach to this problem. Consistent with this new approach, we

analyze both the legal-institutional factors and the characteristics of the corporate ownership structure that can foster the allocation of funds to firms' R&D activities. Thus, although we base our study on a firm-level, we also use some country-level institutional features to assess the extent to which legal and institutional characteristics may affect corporate R&D (Liu et al., 2014; Vanacker et al., 2014).

We make three main contributions to the literature. First, we introduce explicitly the corporate governance international framework. Rather than dividing countries according to their financial system, we introduce the characteristics of the legal and institutional setting in line with Seifert and Gonenc (2012). Second, we focus on a range of shareholders wider than the previous literature one since we also consider other corporations and institutional investors as possible shareholders. Third, we adopt a longitudinal design with the panel data method that allows us to test dynamic responses.

The underlying intuition is that intangible assets are among the corporate assets that require the best legal protection. The creation and exploitation of the corporate knowledge needs a protective legal framework. If firms do not have enough protection to exploit the competitive advantages achieved through R&D, the risk increases that corporate investment in R&D will fall (Thomä & Bizer, 2013). In addition, the law and finance approach suggests that corporate ownership can work as a substitute for the institutional–legal environment approach (La Porta et al., 1997; 1998; 2000b). Consistent with this approach, we conjecture that ownership concentration and the identity of the largest shareholders also have some impact on the firms' incentive to invest in R&D.

The significant institutional differences across the groups of innovative countries supports the intuition that ownership concentration and the identity of the largest

shareholders affect firms' incentive to invest in R&D (Barbosa & Faria, 2011). Glaeser et al. (2004) and Djankov et al. (2007) analyze to what extent national institutions have any effect on a country's economic performance. Their data sets are publicly available and allow the institutional framework of each country to be characterized. Based on this information, we define five variables that characterize each country's institutional environment. Table 1 provides a summary of the variables.

<< INSERT TABLE 1 ABOUT HERE>>

We wonder whether countries in different groups of innovativeness also show differences in terms of institutions. To answer this question, we examine data from the EU members for the five dimensions of institutional quality previously discussed as well as the mean value for each group. Table 2 reports the results. The institutional protection of the economic activity worsens as long as the innovation decreases. Although we cannot set a causal relation, this evidence suggests that the innovativeness of a country is related to the legal and institutional framework.

<< INSERT TABLE 2 ABOUT HERE>>

Our study is divided into five sections. Section 2 looks at the main literature on this topic and introduces the hypothesis to be tested. Section 3 presents the data, the definition of the variables, and the statistical method. Section 4 reports and discusses the results of the empirical estimation. Section 5 includes the most relevant conclusions and some directions for future research.

2. Theoretical background and hypothesis

The agency approach provides useful insights to study the financial problems linked to the corporate R&D (Jensen & Meckling, 1976; Li et al., 2011). The specificity of R&D, the high risk of such activities, and the asymmetric information inherent to R&D

usually result in a risk premium. Consequently, firms tend to prefer to fund R&D with internal funds (Brown et al., 2009; Hall, 1992; Himmelberg & Petersen, 1994). Thus, R&D intensive firms have a sort of optimal capital structure, with a relative reluctance to use debt (Bah & Dumontier, 2001; Chiao, 2002; Singh & Faircloth, 2005).

However, the capital structure of the R&D intensive firms can depend on the characteristics of each country. Anglo-Saxon firms are more prone than their Continental European counterparts to use internal funds for R&D (Bhagat & Welch, 1995; Bond et al., 2003; Bougheas et al., 2003). This prior research suggests that the international differences can be explained on the basis of some legal and institutional characteristics of each country such as capital markets efficiency, the corporate governance system, and the corporate ownership structure.

La Porta et al. (1997; 1998) and Levine (1997; 2005) underline the legal origin of each country to explain the set of economic and financial relations inside the country. They argue that two main legal systems exist: the common law system (the United Kingdom and the United States) and the civil law system (most of Continental Europe and Japan). Creditor and shareholder rights, the enforcement of the law, the quality of the accountancy, and ownership concentration show remarkable differences between these two groups of countries. The common-law system provides the best protection of investors, enforcement of the law, and quality of accountancy (La Porta et al., 1997). The different legal protection of investors is an important determinant of the corporate ownership structure, with worse investor protection leading to a more concentrated ownership structure (Himmelberg et al., 2002; La Porta et al., 1999). Better protection of the investors also indirectly leads to productivity and output growth through more efficient resource allocation (La Porta et al., 2000b).

We emphasize the role played by the institutional environment of each country as a possible determinant of the corporate investment in R&D (Liu et al., 2014). To some extent, the corporate governance system of a country can be understood as a substitute or an outcome of the institutional setting (La Porta et al., 2000a). Consistent with agency theory, conflicts of interests inside firms and managerial risk aversion explain how corporate governance mechanisms impacts corporate R&D. King and Wen (2011) show that weak shareholders governance enhances managerial entrenchment and reduces the most risky expenditures such as R&D. In the same vein, Chen et al. (2013) detect a relation between the mechanisms of corporate governance (namely the board social capital) and R&D expenditures.

Prior research on the influence of the corporate ownership structure on corporate R&D, although extensive, is not conclusive (Hoskisson et al., 2002; Lee & O'Neill, 2003; Tribó et al., 2007). Whereas Baysinger et al. (1991), Hansen and Hill (1991), and Wahal and McConnell (2000) find that institutional investors promote R&D in US firms, Jones and Danbolt (2003) and Graves (1988) suggest a kind of short-termism among institutional investors in the United Kingdom and the United States, respectively, that results in a negative influence on the investment in R&D. Bushee (1998) and Yafeh and Yosha (2003) show that the corporate ownership concentration reduces corporate R&D, which is contrary to the finding of Francis and Smith (1995). At the same time, Holderness and Sheehan (1988) do not detect significant differences in the R&D expenditures among the firms with significant blockholders compared with the firms with dispersed ownership.

We posit that the lack of a clear empirical support may be due to the lack of a framework that introduces legal and institutional issues in an international approach. Thus, we argue that the attitude of shareholders toward corporate R&D depends on how

well their rights are protected. These institutional issues include laws about patents and other R&D results, the reliability and completeness of the information reported on the R&D results, and the protection of the providers of financial resources. These country-specific nonfinancial issues can potentially affect the corporate R&D.

To introduce the effect of the legal setting and the corporate ownership structure on R&D investment, we state six hypotheses. The first hypothesis concerns the legal environment, the second hypothesis concerns the ownership concentration, and the last four hypotheses concern the characteristics of the largest shareholders.

As far as the institutional environment is concerned, some characteristics of R&D—such has the possibility of imitation, the difficulty to retain the human capital on which the innovation bases, and the need for long periods to exploit the innovations—are closely related to how the laws protect the results of the R&D expenditures (Coriat & Weinstein, 2002; Hemmert, 2004). Furthermore, as suggested by agency theory, risk-adverse managers can use discretion in corporate investment in R&D for private benefits extraction (Morck et al., 1988). In terms of agency relations, better legal protection leads to more incentives to undertake R&D expenditures, which are risky, long-term oriented, and do not assure the success of the projects. Thus, we formulate our first hypothesis as follows:

H1: The legal protection of investors has a positive effect on the corporate R&D.

La Porta et al. (1999) show that company law and securities law have key implications for corporate ownership structure. In civil law countries, in which the legal protection of shareholders is poorer, minority shareholders bear the cost of possible expropriation through the private benefits of control. Thus, shareholders react to the lack of legal protection by holding more voting rights and building concentrated ownership structures. From this point of view, ownership concentration is a result of

and a substitute for investors' rights protection. Previous research has analyzed the relation between ownership concentration and R&D investment and has not found any concluding evidence. On the one hand, Bushee (1998), Driver and Guedes (2012), Ortega-Argilés et al. (2005), Tribó et al. (2007), and Yafeh and Yosha (2003) show that the presence of blockholders has a negative influence on R&D expenditures. On the other hand, Francis and Smith (1995) provide opposing evidence, and Holderness and Sheehan (1988) and Choi et al. (2012) do not find any significant relation. A possible explanation to such conflicting results is that the focus of these studies on one single country, and thus they lack an international approach to the institutional environment. We expand this evidence to the international environment by considering corporate ownership concentration as a substitute for the legal framework. In fact, Munari et al. (2010) state that the relation between ownership structure and innovation cannot be fully understood if country-specific factors are not taken into consideration. Thus, we state our second hypothesis as follows:

H2: The concentration of the ownership structure has a positive effect on the corporate R&D of the firms in countries with poor legal protection of investors.

The next hypotheses pertain to the identity of the largest shareholder. Tribó et al. (2007) suggest that the lack of concluding results about the effect of the ownership structure on R&D may be due to the assumption that all the shareholders have the same preferences as for the firm's strategic decisions. Therefore, we identify four types of shareholders with differing attitude toward corporate R&D: (i) banks, (ii) other institutional investors (e.g., investment funds, pension funds, foundations, etc.), (iii) nonfinancial companies, and (iv) particular investors and families.

As far as banks as shareholders are concerned, previous literature shows mixed results. According to Lee (2005), bank ownership has a positive effect on R&D investment in Japan and US firms. Conversely, Tribó et al. (2007) detect a negative effect in the Spanish firms, and Kochhar and David (1996) do not find any significant relation. Once again, these results may be due to the lack of international scope given that banks can play a different role across countries (Allen & Gale, 2001; Kroszner et al., 2007; Shrieves et al., 2010). Banks as shareholders usually have conflicting interests because they are also creditors. Thus, banks are interested in decreasing corporate risk taking to preserve the solvency of the firm. Given the high risk of R&D investment, we state our third hypothesis:

H3: The proportion of equity owned by banks has a negative effect on the corporate R&D.

Other institutional investors such as pension funds, mutual funds, foundations, and so on can have a different attitude than banks toward corporate innovation. Eng and Shackell (2001) and Hall and Weinstein (1996) suggest that these kinds of investors have a more long-term orientation and provide managers with a longer time framework to take strategic decisions. Conversely, Driver and Guedes (2012) y find that large institutional holdings decrease R&D. Because R&D returns usually take longer than other investments, institutional investors as shareholders are likely to promote the investment in R&D. Thus, we state our fourth hypothesis:

H4: The proportion of equity owned by institutional investors has a positive effect on the corporate R&D.

Nonfinancial firms as shareholders has an unclear effect on corporate R&D, conditional on the nature of their stake. Firms that own stakes in other firms for strategic and control purposes have a more long-term orientation, and thus they are

likely to promote long-term investments such as R&D. In this vein, Gompers and Lerner (1998) underline the potential synergies and transfer of technology within a group of such firms. Conversely, when owner firms have a speculative purpose and are primarily interested in short-term profitability, they are likely to prefer reduced risk and thus lower corporate investment in R&D. As discussed in Section 3, our data come from consolidated financial statements, in which the structural investments have been dropped. Hence, our data are basically the results of speculative short-term blockholding. Thus, we state our fifth hypothesis:

H5: The proportion of equity owned by nonfinancial firms has a negative effect on the corporate R&D.

Finally, a wide variety of circumstances and preferences can impact individual investors' relation to corporate R&D (Baysinger et al., 1991). Their different attitudes toward the risk and the time horizon of their stake do not allow us to hypothesize a clear direction of influence (Tribó et al., 2007). Thus, we state last hypothesis:

H6: The proportion of equity owned by individual investors does not have a significant effect on the corporate R&D.

3. Sample, variables, and methodology

3.1. Sample

We select our sample according to the method used in the European Innovation Scoreboard published annually by the European Commission. The report from 2008 shows that the five most R&D intensive sectors are (i) the pharmaceutical sector, (ii) the biotechnological and medical research sector, (iii) the car manufacturing sector, (iv) the sector of new technologies and computer systems, and (v) the telecommunications sector.

We build a sample with all the listed companies from these industries from 19 countries (Germany, Australia, Austria, Belgium, Canada, Denmark, Spain, United States, Finland, France, United Kingdom, Greece, Ireland, Italy, Japan, Luxembourg, Holland, Portugal, and Sweden) between 2003 and 2007.[3]

The choice of 2007 as the end of the period is purposeful to avoid the disturbing consequences of the current financial crisis on R&D expenditures. The OECD (2010) shows that the economic crisis has led to sluggish growth in R&D spending by firms, notably in southern and eastern Europe. Likewise, the OECD (2012) acknowledges the dramatic effect on innovation domains and policies and the negative impact on innovation worldwide. The European Commission (2012) shows that the recent crisis episodes threaten the growth of the most innovative industries. With these caveats, we analyze the period immediately preceding the current crisis, which is still ongoing in some countries. Table 3 shows the final sample, which is made up of 4,585 observations from 1,091 firms.

Table 3 also gives an idea of the representativeness of our sample. We report the proportion of the national stock market capitalization of which our sample accounts. On average, the firms in the sample account for around one-fifth of the capital market, with a higher representation for the common law countries. The country with the highest coverage is the United States, and the country with the lowest coverage is Italy.

<< INSERT TABLE 3 ABOUT HERE>>

The financial information from each firm comes from the consolidated financial statements. The consolidation of financial statements eliminates the structural

[3] The sample initially included 1,852 firms but the information about the corporate ownership structure (i.e., distribution of shares among shareholders and identity of the largest shareholders) is not available for many of them. In addition, we select a random sample of Japanese and US firms to avoid an unbalanced sample due to the overrepresentation of these countries. The selection has been made according to size and industry criteria to avoid any bias.

investments so that the possible duplicity in R&D investment through affiliated firms is ruled out. The analyzed firms can use two kinds of accounting rules: the International Financial Reporting Standards and the Generally Accepted Accounting Principles. Both kinds of rules have consistent criteria regarding R&D registration so that differences in accounting procedures do not bias our results. Nonetheless, we control for such differences by including year dummy variables because the International Financial Reporting Standards rules were not applicable in 2003 and 2004.

3.2. Variables

We measure the intensity of the R&D investment by the change in the intangible assets between two periods scaled by the firm's turnover (RD). The ideal measure of corporate R&D is R&D expenditures (Herrera et al., 2010). However, as noted in previous literature on corporate R&D, such information is scarce, and employing it would dramatically decrease the sample (Ballester et al., 2003; Hall & Oriani, 2006). In addition, the possibility of manipulating R&D expenses (García Osma, 2008) has led some prestigious international institutions including the European Techno-Economic Policy Support Network and the European Union Industrial R&D Investment Scoreboard to recommend the part of the R&D expenditures actually incorporated into the assets as one of the most suitable metrics of the corporate investment in R&D. This variable has theoretical support (Denicolai et al., 2014; García-Valderrama & Mulero-Mendigorri, 2005; Leitner, 2005; Martínez-Torres, 2014) and has also been widely used in the literature, which enhances the comparability of our results (Audretsch & Weigand, 2005; Bond et al., 2003; Hall et al., 1999; Mulkay et al., 2001; Tribó et al., 2007).

Regarding the institutional setting, consistently with La Porta et al. (1997, 1998), we classify the 19 countries in our sample into two groups according to the investors'

legal protection: common law countries (United Kingdom, Australia, Ireland, and United States) provide better legal protection than their civil law counterparts (the remainder of the sample). Thus, we define the LEGAL variable, which equals 1 for common law countries, and zero otherwise.

The characteristics of the corporate ownership structure are twofold. First, following Maury and Pajuste (2005), we compute the ownership concentration through a Herfindahl index (HERF) based on the stake of the five largest shareholders. This variable ranges from 0.2 (maximum dispersion) to 1.0 (maximum concentration). Second, we define four variables, BANK, INST, CORP, and INDIV, as the proportion of shares owned by banks, other institutional investors, other corporations or nonfinancial firms, and individuals respectively. Table 4 reports the number of firms and observations depending on the nature of the largest shareholder. The second row reports in how many firms some of these shareholders own shares and the third row reports in how many firms some of these shareholders are the largest owner.

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To enhance the comparability of our results, we follow prior literature and control for some corporate financial issues: financial leverage (LEV), liquidity (LIQ), performance (ROA), and size (LOGAST). LEV is defined as the debt to equity ratio. Given the risk of R&D activities and creditors' risk aversion, this variable should have a negative effect on R&D. LIQ is the proportion of cash and short-term investments over total assets. Because corporate liquidity enables any kind of investment, it should have a positive influence on R&D. ROA is the return on assets, measured as gross profits over total assets. According to accounting rules, R&D expenditures are considered an expense, and thus ROA is likely to have a negative relation with R&D. The size of the

firm is measured as the log of total assets. All the variables are summarized in the Appendix.

3.3. Method

As previously stated, our sample includes 1,091 firms over five years, which provides a 4,585-observations panel data. The panel data methodology is the most accurate method for at least two reasons (Arellano, 2003). First, panel data methodology allows us to control for unobservable constant heterogeneity (i.e., fixed effects), and it renders more efficient estimators than the cross-sectional models. Second, panel data methodology addresses the problem of endogeneity through the generalized method of moments. To tackle endogeneity issues, we estimate our model using Blundell and Bond's (1998) and Bond's (2002) panel data system estimator. In the R&D arena, García-Manjón and Romero-Merino (2012) also use this method. Given the possibility that weak instruments can induce poor asymptotic precision (Alonso-Borrego & Arellano, 1999), a generalized method of moments system estimator provides the most efficient estimates. In this context, the choice of instruments is a key decision, and we use all the right-hand-side variables up to two years lagged.

The consistency of the estimates depends critically on the absence of second-order serial autocorrelation in the residuals and on the validity of the instruments Arellano and Bond (1991; 1998). Accordingly, we report the tests of the specification of the model in the tables of the results. To test the validity of the instruments, we use the Hansen test of overidentifying restrictions, which allows us to test the absence of a correlation between the instruments and the error term and, therefore, to check the validity of the chosen instruments. We also report the test for autocorrelation of second order (m2) to check that such correlation is not a relevant problem.

4. Results

Table 5 reports some descriptive statistics including mean, standard deviation, and quartiles of the variables. These values are within the expected range, and therefore we rule out the possibility of our results being due to a mistaken sample selection. Due to the concern about a possible multicollinearity problem, we perform the variance inflation factor (VIF), a multicollinearity test. Table 6 reports the results, along with the coefficients of correlation between variables. The closer the VIF is to 1, the lower the degree of multicollinearity is. The results shows that the VIF is very close to 1 in all of the cases, and thus the absence of multicollinearity can be accepted (Kutner et al., 2005).

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Given the important role played by the institutional setting in our research, in Table 7 we report the mean value for each legal environment, and we provide the *p*-value for the test of means comparison.[4] Consistent with our first hypothesis, the results show that corporate investment in R&D is significantly higher in the common law countries, allegedly due to the better legal protection of shareholders. In the civil law countries the corporate ownership structure is less concentrated, which is consistent with the view of ownership concentration as a substitute for shareholders' legal protection. Also, the proportion of shares held by banks, other firms, and individuals is higher in the civil law framework, whereas institutional investors have a higher stake in the common law countries (Allen & Gale, 2001; Li et al., 2006).

<< INSERT TABLE 7 ABOUT HERE>>

[4] The *p*-value is the highest significant level to reject the null hypothesis of equal mean between both groups. The lower the *p*-value is, the more significant the differences are between groups.

Table 8 reports the results of the test of means comparison when we divide the sample according to the RD variable. We divide the whole sample into three groups with the same number of observations in each group, and we compare the groups with the highest and the lowest R&D investment. Although not conclusive, these results are consistent with our hypotheses. The Herfindahl index (HERF) suggests that corporate ownership is more concentrated in the firms with higher R&D (Hypothesis 2). The most R&D intensive firms have a lower proportion of banks as shareholders (Hypothesis 3), a higher proportion of other institutional investors (Hypothesis 4), and a lower proportion of nonfinancial firms (Hypothesis 5). In addition, the proportion of shares held by individuals does not show significant differences depending on corporate R&D (Hypothesis 6). The values of the control variables are also consistent with our expectations: The most R&D intensive firms have higher liquidity and lower financial leverage and performance.

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The previous comparisons, although consistent with our hypotheses, only provide preliminary evidence and require corroboration by explanatory analysis. Table 9 reports the results of the estimations concerning the effect of the legal and institutional setting. As shown in column 1, the legal and institutional environment (LEGAL) has a positive influence on the RD variable, which supports Hypothesis 1. Columns 2 and 3 in Table 9 are the estimates for the civil law and the common law countries, respectively. Both columns provide information about the effect of ownership concentration in each institutional scenario. In the civil law environment, where investors' rights are not as well protected, ownership concentration is positively related to R&D investment. Conversely, corporate ownership concentration does not play any significant effect in the common law environment. Thus, in line with Hypothesis 2, ownership concentration

works as a substitute for shareholders' legal protection due to the difficulty in preserving the competitive advantages achieved through corporate R&D.

<< INSERT TABLE 9 ABOUT HERE>>

The control variables have the expected influence: Liquidity positively affects R&D investment, whereas financial leverage and the performance of the firm have a negative effect. These results are congruent with similar previous research (Bah & Dumontier, 2001; Bates et al., 2009; Martinsson, 2010).

Table 10 reports the estimates of the effect of shareholders' identity. In each column the variable OWN is the proportion of shares held by each type of shareholder. These results support Hypotheses 3 through 6. Column 1 shows that bank participation in firm ownership reduces corporate investment in R&D (Hypothesis 3). The effect of the fraction of shares held by institutional investors (column 2) is positive, in line with Hypothesis 4. The proportion of shares owned by other nonfinancial companies has a negative influence on corporate R&D (column 3), whereas the proportion of shares in the hands the individual investors does not have any significant effect (column 4).

The control variables have the expected influence: Corporate liquidity positively affects corporate R&D investment whereas corporate debt and performance have a negative impact on R&D investment. The exception is the lack of significance of the capital structure when banks are the largest shareholders (column 1). This result may be due, as suggested by Elston (1998), Elsas and Krahnen (1998), and Espenlaub et al. (2012) to the fact that firms owned by banks have easier access to debt, and thus financial leverage is not a significant determinant of corporate R&D.

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To check the robustness of our estimates, we run an additional analysis that focuses only on the firms in which banks, institutional investors, other nonfinancial firms, or individuals control the firm by owning more than 50 percent of shares. Table 11 reports the results, which corroborate the previous findings. The coefficient of the ownership variable is negative and significant when banks or other nonfinancial firms are the largest shareholders and positive when institutional investors are the main shareholders. The results for the control variables are also consistent with previous findings. The effect of financial leverage for firms held by banks as the largest shareholders (column 1) is again negative and significant. This result may be due to the risk aversion of banks when they are simultaneously creditors and shareholders (Kroszner & Strahan, 2001).

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5. Concluding remarks

This study combines agency theory and the legal and institutional point of view to study problems related to funding corporate R&D. Corporate R&D investment has some features that usually lead to a higher cost of funds for R&D expenditures. Coherent with the law and finance approach, we argue that the legal and institutional setting of a country and the corporate ownership structure can enhance the R&D investment by reducing the possible discretionary use of such expenditures. This approach is especially interesting currently because the financial crisis has produced a dramatic shortage of public funds for R&D. As a result, firms face the need to keep R&D expenditures in an environment of financial constraints.

We begin by determining whether countries at different stages of innovation performance show marked differences in terms of their legal and institutional

framework. More specifically, we check whether the quality of the institutional environment of a country worsens as innovation decreases. Based on that intuition, we analyse to which extent the legal protection of investors is a determinant of corporate R&D. In addition, because the financial literature shows that the ownership structure can work as a substitute of the institutional framework, we also study the effect of corporate ownership structure on R&D investment.

We analyze the R&D investment of 1,091 listed firms from 19 countries between 2003 and 2007. The firms belong to the five most innovative industries according to the European Union Innovation Scoreboard published by the European Commission. Our results show that better legal protection of investors leads to higher corporate R&D. In other words, R&D expenditures are higher in the institutional environments that better preserve the rights of investors to exploit the competitive advantages achieved through R&D.

We also shed some light on the influence of the ownership structure on R&D investment. Our results stress the relevance of the corporate ownership structure. Coherent with the legal–financial approach, our results show that ownership concentration is a mechanism of protection when investors are not well protected by laws. Thus, ownership concentration has a positive influence on the R&D investment of firms within civil law countries (i.e., firms in the countries with poor protection of shareholders' rights). The identity of shareholders also has a relevant effect. Banks and other nonfinancial firms as shareholders have a more short-term and risk-avoidance orientation that results in lower R&D investment of the firms whose shares they own. Conversely, the presence of institutional investors as shareholders has a positive effect.

One direction for future research includes focusing on the effect of the institutional environment on corporate R&D. It would be interesting to study more in-depth the

different features of the institutional setting potentially affecting the R&D expenditures to determine their differential effect. Another direction for future study is the interaction between financial and institutional elements to design the optimal structure of both mechanisms that promotes corporate R&D in each country. This research may allow firms to improve the efficiency of the R&D investment without additional burden for public funds.

Appendix: Variables definition

Abbreviation	Variable	Definition
RD	Corporate R&D investment	Variation in intangible assets between two consecutive years / Total sales
OWN	Shareholders proportion	Proportion of shares held by each type of shareholder
LEGAL	Investors legal protection	1 for common law countries and zero for civil law countries
HERF	Ownership concentration	$\sum C^2_i / \sum C_i$, where C_i is the proportion of shares held by each one of the five largest shareholders
BANK	Equity owned by banks	Proportion of shares held by banks
INST	Equity owned by institutional investors	Proportion of shares held by institutional investors
CORP	Equity owned by other nonfinancial firms or corporations	Proportion of shares held by other nonfinancial firms
INDIV	Equity owned by families and individuals	Proportion of shares held by individuals
LOGAST	Company size	Log of total assets
LEV	Financial leverage	Total debt/Equity
LIQ	Corporate liquidity	Cash & short term financial assets/ Total assets
ROA	Asset performance	Gross profit / Total assets

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Table 1: Variables defining the country legal and institutional framework

Variable	Scoring
Government repudiation of contracts	From 0 to 10
Bureaucracy quality index	From 0 to 10
Corruption index	From 0 to 10
Rule of law	From 0 to 6
Ownership rights protection	From 0 to 5

Source: Glaeser et al. (2004)) and La Porta et al. (1998)).

Table 2: Institutional environment and innovation

Country	Contracts	Bureaucracy	Corruption	Law	Ownership
Sweden	9.6	10.0	10.0	6.0	4.0
Denmark	9.3	10.0	10.0	6.0	5.0
Germany	9.8	9.9	8.9	5.5	5.0
Finland	9.1	10.0	10.0	6.0	5.0
Leaders	**9.5**	**10**.0	**9.7**	**5.9**	**4.8**
Belgium	9.5	10.0	8.8	6.0	5.0
UK	9.6	10.0	9.1	5.1	5.0
Holland	9.4	10.0	10.0	6.0	5.0
Austria	9.6	9.4	8.5	6.0	5.0
Luxemburg	10.0	10.0	10.0	6.0	1.0
Ireland	9.0	9.1	8.5	4.7	5.0
France	9.2	10.0	9.0	5.4	4.0
Slovenia	7.0	6.7	7.2	n.a.	3.0
Cyprus	7.5	7.2	6.2	3.6	3.0
Estonia	n.a.	n.a.	n.a.	n.a.	n.a.
Followers	**8.9**	**9.0**	**8.5**	**5.4**	**3.9**
Italy	9.2	7.4	6.1	5.0	4.0
Portugal	8.6	6.2	7.4	5.2	4.0
Czech Rep.	n.a.	n.a.	n.a.	n.a.	4.0
Spain	8.4	6.8	7.4	4.7	4.0
Hungary	7.2	6.8	7.5	5.1	n.a
Greece	6.6	5.6	7.3	3.7	4.0
Malta	6.9	5.0	5.8	3.3	2.0
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	n.a.	n.a.	n.a.	n.a.	n.a.
Moderate	**8.1**	**6.7**	**7.3**	**4.7**	**3.8**
Romania	5.0	2.5	4.9	3.0	2.0
Latvia	n.a.	n.a.	n.a.	n.a.	3.0
Bulgaria	6.6	5.0	6.5	5.0	3.0
Modest	**5.8**	**3.8**	**5.7**	**4.0**	**2.7**

Source: Authors' calculations based on La Porta et al. (1998)).

Table 3: Sample composition by country legal and institutional framework

This table shows the number of firms and firm-year observations from each country and the proportion of the national stock market capitalization of which our sample accounts.

Civil law countries				**Common law countries**			
Country	**firms. (*n*)**	**obs. (*n*)**	**%**	**Country**	**firms (*n*)**	**obs. (*n*)**	**%**
Germany	61	241	18.04	Australia	13	59	2.52
Austria	3	15	3.30	United States	451	1,902	43.54
France	40	148	5.31	Canada	32	127	3.65
Spain	5	14	7.96	United Kingdom	76	301	
Finland	15	63	6.30	Ireland	5	17	19.99
Belgium	3	10	9.87				
Denmark	10	46	18.57				
Japan	328	1,449	8.95				
Holland	10	45	15.27				
Sweden	17	75	4.86				
Greece	8	26	1.35				
Italy	9	27	0.77				
Luxemburg	2	7	0.77				
Portugal	3	13	8.61				
Civil law	**514**	**2,179**	**14.05**	**Common law**	**577**	**2,406**	**28.37**

Table 4: Sample composition by type of shareholder

This table shows the number of firms and firm-year observations in the sample in which a bank, an institutional investor, a corporation or an individual owns shares or is the largest shareholder.

	BANK	INST	CORP	INDIV
No. companies	253	1,087	590	668
No. observations as shareholder	700	4,555	2,036	2,223
No. observations as the largest shareholder	87	2,356	1,074	1,068

Table 5: Descriptive statistics

Table shows mean, standard deviation, and quartiles of the main variables. See the Appendix for definitions of the variables.

Variable	Mean	Std. Dev.	Q25	Q50	Q75
RD	9.67	9.05	2.19	7.04	15.30
HERF	0.34	0.19	0.22	0.26	0.37
BANK	0.01	0.026	0.00	0.00	0.00
INST	0.182	0.055	0.05	0.14	0.28
CORP	0.10	0.18	0.00	0.00	0.13
INDIV	0.12	0.64	0.00	0.00	0.16
LOGAST	5.54	2.22	4.01	5.16	6.78
LEV	0.14	0.17	0.00	0.07	0.23
LIQ	0.27	0.21	0.10	0.22	0.40
ROA	0.09	0.18	0.04	0.10	0.16

Table 6: Correlation matrix and vector inflation factor

See the Appendix for definitions of the variables.

	RD	**HERF**	**BANK**	**INST**	**CORP**	**INDIV**	**LOGAST**	**LEV**	**LIQ**
HERF	0.020								
BANK	–0.025	–0.091							
INST	0.035	–0.329	–0.214						
CORP	0.024	0.526	0.011	–0.362					
INDIV	–0.008	0.112	–0.040	–0.084	–0.055				
LOGAST	–0.033	–0.080	0.100	0.053	–0.065	–0.054			
LEV	0.017	–0.034	0.109	–0.028	–0.020	–0.020	0.154		
LIQ	0.101	–0.073	–0.187	0.188	–0.125	0.011	–0.183	–0.253	
ROA	–0.117	–0.018	0.010	–0.035	–0.020	0.016	0.168	–0.163	–0.149
VIF		1.49	1.12	1.3	1.51	1.04	1.10	1.14	1.19

Table 7: Legal environments comparison

This table provides the mean value of each variable in both legal environments. The *p*-value is the highest level of significance to reject the null hypothesis of equal means between both subsamples. See the Appendix for definitions of the variables.

Variable	Civil law	Common law	*p*-value
RD	7.05	11.95	0.00
HERF	0.40	0.29	0.00
BANK	1.50	0.15	0.00
INST	9.19	26.27	0.00
CORP	18.22	3.86	0.00
INDIV	15.13	9.26	0.00
LOGAST	5.36	5.70	0.00
LEV	0.16	0.12	0.00
LIQ	0.22	0.31	0.00
ROA	0.09	0.09	0.66

Table 8: Means comparison depending on corporate R&D

This table provides the mean value of each variable depending on the intensity of corporate R&D. The *p*-value is the highest level of significance to reject the null hypothesis of equal means between both subsamples. See the Appendix for definitions of the variables.

Variable	**High R&D**	**Low R&D**	***p*-value**
HERF	0.36	0.32	0.00
BANK	0.37	1.35	0.00
INST	22.20	13.03	0.00
CORP	7.34	15.23	0.00
INDIV	12.87	11.97	0.76
LIQ	0.36	0.19	0.00
LEV	0.10	0.18	0.00
ROA	0.05	0.11	0.00

Table 9: Effect of the legal environment and ownership concentration

This table provides the estimated coefficients (standard error) from the generalized method of moments estimation. The dependent variable is the corporate research and development (RD). The independent variables are defined in the Appendix. We control for time and industry effects. m2 is a test of second order serial autocorrelation of the residuals under the null hypothesis of no serial correlation. The Hansen test is a test of overidentifying restrictions, asymptotically distributed as $\chi 2$ under the null hypothesis of no correlation between the instruments and the error term (degrees of freedom). ***, **, and * denotes 99%, 95%, and 90% confidence level, respectively.

Variable	Whole sample (1)	Civil law (2)	Common law (3)
LEGAL	2.983***		
	(0.671)		
HERF		11.118***	–13.919
		(3.567)	(10.570)
LIQ	4.147**	7.472***	8.686***
	(1.775)	(1.393)	(3.287)
LEV	–31.924***	–5.498*	–21.444**
	(5.623)	(3.145)	(9.827)
ROA	–18.914***	–7.453***	–19.069***
	(1.987)	(1.528)	(2.866)
LOGAST	0.278*	–0.160**	0.061
	(0.164)	(0.150)	(0.288)
No. obs.	3,669	1,764	1,905
m2	–0.61	–0.50	–0.17
Hansen (d.f.)	53.20 (45)	40.59 (45)	31.08 (45)

Table 10: Effect of the type of shareholder identity

This table provides the estimated coefficients (standard error) from the generalized method of moments estimation. The dependent variable is the corporate research and development (RD). OWN is the fraction of shares held by each type of shareholders. The other independent variables are defined in the Appendix. We control for time and industry effects. m2 is a test of second order serial autocorrelation of the residuals under the null hypothesis of no serial correlation. The Hansen test is a test of overidentifying restrictions, asymptotically distributed as $\chi 2$ under the null hypothesis of no correlation between the instruments and the error term (degrees of freedom). ***, **, and * denotes 99%, 95%, and 90% confidence level, respectively.

	Banks	**Institutional**	**Corporation**	**Individual**
OWN	–4.302***	0.349***	–0.466***	0.029
	(0.914)	(0.078)	(0.074)	(0.018)
LIQ	4.260**	10.328***	5.396***	14.667***
	(1.913)	(1.258)	(1.607)	(1.133)
LEV	2.986	–2.545*	–6.459***	–2.750*
	(2.474)	(1.443)	(1.602)	(1.560)
ROA	–11.274***	–14.296***	–15.864***	–20.110***
	(1.942)	(11.631)	(1.836)	(2.394)
LOGAST	–1.304**	–0.209	–0.340*	0.088
	(0.593)	(0.289)	(0.176)	(0.116)
No. obs.	3,793	3,793	3,669	3,669
m2	–1.40	–0.12	0.40	0.34
Hansen (d.f.)	32.86 (45)	37.29 (45)	67.75 (45)	39.85 (45)

Table 11: Effect of the dominant shareholders identity

This table provides the estimated coefficients (standard error) from the generalized method of moments estimation. The dependent variable is the corporate research and development (RD). The independent variables are defined in the Appendix. We control for time and industry effects. m2 is a test of second order serial autocorrelation of the residuals under the null hypothesis of no serial correlation. The Hansen test is a test of overidentifying restrictions, asymptotically distributed as $\chi 2$ under the null hypothesis of no correlation between the instruments and the error term (degrees of freedom). ***, **, and * denotes 99%, 95%, and 90% confidence level, respectively.

Variable	**Banks**	**Institutional**	**Corporation**	**Individual**
OWN	–0.118***	0.089*	–0.111***	0.010
	(0.040)	(0.051)	(0.041)	(0.014)
LIQ	29.280***	3.567*	12.675***	10.340***
	(–1.611)	(–1.906)	(–2.418)	(–1.569)
LEV	–6.661***	–5.568*	–5.653*	–7.893***
	(–1.209)	(–2.863)	(–2.940)	(–1.901)
ROA	–6.964***	–24.895***	–17.877***	–10.743***
	(–2.474)	(–2.085)	(–4.856)	(–1.511)
LOGAST	0.776***	–0.155	0.030	0.150
	(0.157)	(0.182)	(0.256)	(–1.246)
No. obs.	41	1,812	715	804
m2	0.13	–0.08	–0.23	0.31
Hansen (g.l.)	11.65 (45)	73.25 (45)	19.10 (45)	36.93 (45)

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