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Ownership Structure and Innovation: Is There a Real Link?

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Ownership structure and innovation:

Is there a real link?

(Preliminary Version - April 2003)

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Abstract: this work focuses on the study of the relationship between ownership structure and control of the company and its innovative activity. Taking Geroski's model as a starting point, its aim is to analyse the role that may be played by determinants within the company related to ownership structure when the decision to incur research and development costs is taken. Conclusions may be drawn from the analysis regarding the effect of mechanisms adopted to alleviate the problems of agency that arise because of the lack of identity between ownership and control in decision-making posts on the management of innovative activities in the company. The study was carried out for the years 1994 and 2000, using a representative sample of Spanish manufacturing industries.

Keywords: ownership and control structure, research and development, agency theory.

JEL classifications: D210, O310, G320.

1. INTRODUCTION

In recent years, companies have become aware of their need to encourage their capacity for innovation. This has reached the point where it has come to be understood as a continuous process that is not formulated in order to attain a specific objective, but instead one that is included in the company's strategy, becoming institutional. Companies feel that they are safer from possible competition by formalising their own innovations in the patents and trademarks register. All types of activities are involved in obtaining this objective - scientific, technological, organisational, financial and commercial.

There is a great deal of recent literature which deals with the study of the determinants in innovation. These studies may be categorised as macroeconomic, which try to explain the potentialities in various geographical units in the field of innovation, and microeconomic studies, which analyse the internal determinants within the company to explain innovative efforts and results. Some questions such as the effect of the company's size, its age, its degree co-operation with other companies or financing, both internal and external, have been analysed in detail in the microeconomic studies. However, there have been few studies which have tried to explain the effect of variables, such as the decision-making structure or ownership and how they may influence decisions to invest in the company.

A company's ability to innovate depends on a series of factors, in such a way that whether or not they are present has a favourable or unfavourable influence on the innovation process. These factors may be placed in the following groups:

1. The existence of favourable conditions in the demand structure or in the market size, in the life cycle of the products it manufactures, or in the evolution of scientific and technical means that it may use.
2. The resources that the company allocates to engineering, design, research and marketing.

Moreover, the favourable conditions mentioned above and the company's technical capacity must be integrated in the framework of an innovative strategy, and then the following factors become involved:

3. The company's management and organisation.
4. Its desire to differentiate its products or processes from those of its competitors.

Considering the possible significance of the company's management and organisation with regard to its innovative activity, we feel that there is a need to analyse the characteristics of the ownership structure of the company - who owns it and how the control of decision-making is distributed, the nature of this control, the percentage of its capital owned by managers¹ and the level of concentration of ownership, among other issues. The characteristics that may lead to good management of the company's resources, both financial and physical, are innumerable. This will be determinant in the achievement of good results in the company's innovative process, which will determine its growth and its future.

In order to draw conclusions regarding the role of organisational strategy in business decisions, and in investment decisions in particular, it is necessary to consider the literature concerning capital structure in depth. The literature analysing the subject of ownership and control has provided interesting articles (Jensen, 1986; Himmelberg et al., 1999; Hermanlin and Weisbach, 1991; and Kole, 1995; among others), with the objective of studying how companies' capital and financial structure determines their opportunities for growth. There are also articles in Spanish literature (Galve and Salas, 1993; De Andrés-Alonso et al., 2000; and Rodríguez, 1996; among others). These have tried to explain companies' results taking the structure of the company's share capital, the concentration of ownership and the type of main investor as explanatory variables.

While there are some studies that contain models analysing the determinants of companies in the decision to invest in R & D (Crépon et al., 1996; Geroski and Pomroy, 1990; Beneito, 2001; Love et al., 1996; and Gumbau, 1997; among others), there are very few that include any type of ownership structure variable in their study, which in the case of Spanish industry, have not been very widely disseminated. Other works analyse what the determinants are in the creation of the company's value, introducing variables which include the structure of capital and control of the company into their analysis, but in most cases they do not analyse the process of innovation, due to a lack of information.

Our work focuses on the study of the relationship between company ownership and control structure and decisions to invest in innovation. Its aim, based on the literature both in the field of ownership structure and in the field of innovation, is to analyse the role that may be played by

¹ In this study, we will use the terms "manager" and "director" indiscriminately to designate workers in decision-making positions.

internal determinants in the company related to its ownership structure when taking the decision to incur R & D costs. Furthermore, when the control mechanisms for alleviating the possible agency problems arising due to the lack of identity between ownership and control are studied, it can be seen that they are directly related with companies' ownership structure. From the analysis carried out here, conclusions can thereby be drawn as to whether this type of mechanism plays a determinant role in the decisions to invest in innovations by the companies analysed.

The article is structured in five parts. After the short introduction, which we have used as a guide to identify the determinants to be considered in our study, and the presentation of our objective, we briefly summarise the main theories concerning ownership structure in the following section. This section also contains a short review of the empirical literature in the field of ownership structure in company results. The third section describes the characteristics of the sample and the methodology followed. In the same section, the general objective is set out, establishing the hypotheses that we aim to test, and the variables considered in our analyses are discussed. The fourth section shows the results obtained during empirical research. Finally, the main conclusions drawn from our analysis are presented.

2. THE RELATIONSHIP BETWEEN OWNERSHIP STRUCTURE AND INNOVATION. WORKING HYPOTHESIS.

Articles based on the literature analysing the structure and control of the company base many of their results on two main theories - managerial company theory and the economic theory of organisations². Managerial company theory, in which the manager has complete freedom of action, argues that the managerial company reduces its profitability because of the differences between the manager's objective function and the function of maximising profits for shareholders. The extensive economic theory of organisations argues that the structure of ownership and organisational design directly influences productive efficiency. Within this theory, there are three of the theories that have mainly been used to provide arguments for the results of this type of study - agency theory, hierarchical bureaucracy theory and transaction cost theory.

² For more information, see Milgrom and Roberts (1992).

Agency theory specifically recognises the conflict of interests in companies with various owners, shareholders and creditors who in turn relate to a non-owning administrator, leading to alternative mechanisms being used (contracts, effective control, debt financing) in an attempt to overcome conflicts, respecting the limits imposed by the information available (Jensen and Meckling, 1979). Hierarchical bureaucracy theory states that large companies are generally structured in hierarchical levels which are tools for the co-ordination and transmission of information, as well as instruments for hierarchical control and supervision. The hierarchy carries out these functions imperfectly, so that often the level of imperfection, and with it, the company's overall efficiency varies depending on the company's size and its control situation. Finally, transaction cost theory demonstrates that once again, "the total can be greater than the sum of the parts".

Many studies, on an empirical level, have attempted to study the importance of ownership structure on a company's possibilities for growth and success and therefore to what extent the questions analysed by the various managerial company theories and the economic theory of organisations are confirmed in the field to which they are replied. Given that in this study we start with the idea that this question is deeply related to the company's opportunities for obtaining innovative results providing it with future growth, their conclusions may be of interest to our study.

Among the works analysing the relationship between capital structure and opportunities for growth are those by Smith and Watts (1992) and Lasfer (1995). The first analyses how financing decisions, on the one hand, and management remuneration policy, on the other, may influence the company's investments and opportunities for growth, with a negative relationship obtained between opportunities for growth and debt, something which provides the opportunity to regulate the agency conflicts affecting them. Lasfer's work confirms the positive influence of "leverage"³ on those cases in which the company does not have valuable opportunities for growth, as proposed by Jensen (1986) and Stulz (1990). Himmelberg et al. (1999) also analyses the determinants of company value by applying panel data, arguing that the heterogeneity that is not observed generates a spurious correlation between ownership and opportunities for growth.

³ "Leverage" is understood to be the effect that occurs on risk and the level of variability in a company's results due to the effect of having increased external financing.

By carrying out a short review of the literature which relates Tobin's Q ratio⁴ with the "managerial ownership"⁵ variable, it can be seen that the creation of value has no relationship of a lineal nature with ownership, as the value of the company increases and decreases for various proportions of ownership in the hands of its directors. Among the studies analysing this area are several that obtain an inverted U-shaped relationship (McConnell and Servaes, 1990; Mørck et al., 1988; Holderness et al., 1999). The study by Kole (1995) examines the differences in the works mentioned above and concludes that differences in business size may lead to differences in the conclusions drawn by this type of work. Moreover, they do not take into account the problem of endogeneity involved in the use of the variable "managerial ownership" as an explanatory variable, as noted by Jensen and Warner (1988).

Leech and Leahy (1991) carry out a study using data from British companies, with the aim of describing the ownership structure of a sample of large companies and carrying out an econometric analysis of its causes and consequences in terms of control and incentives. They feel that the ownership structure and its level of concentration have an important role in the growth of the company. Using the regression model in which including variables related to the utility functions of the directors, shareholders and owners, they conclude that the company's opportunity for growth depends on the concentration of ownership and the directors' control.

In Spain, Galve and Salas (1993) carried out an empirical study with the aim of analysing the shareholding composition of Spanish companies and to check whether there were differences in the financial results that were attributable to the type of the owner group controlling the company. They gave details of the mechanism by which the ownership-control influences results, with a positive relation shown between concentration of ownership and the results obtained by the company, as well as family ownership type. In the work by De Andrés-Alonso et al. (2000), which aimed to study the impact of the decision to become indebted and contractual structure on the market value of companies, the conclusion is drawn that concentration of ownership is a harmful influence in the presence of opportunities for growth. A positive relationship between directors' shareholdings and the creation of value in the absence of opportunities is not proved.

⁴ Tobin's Q ratio is a proxy valuable in the creation of value. One of the most often used ratios is the quotient between the value of shares and the sum of the company's debt in the financial market and the cost of repositioning its real assets.

Literature concerning ownership structure and its effect on the growth of companies has been analysed up to this point. However, as far as we know, there are hardly any works concerning the role that may be played by a company's ownership structure and the way in which it is constituted and administered on decisions as important as the innovative strategy to be adopted. Some aspects related to ownership structure, among other questions, are only analysed in the works by Love et al. (1996), Dixon and Seddighi (1996) and Acs and Isberg (1991). In the first of these, a sample of Scottish companies is analysed, with the conclusion that foreign ownership has a positive effect on the probability of a company located in Scotland obtaining product innovations. In the work by Dixon and Seddighi, carried out with a sample of English companies, the effect of the type of ownership (domestic or foreign) is analysed. In this work, as well as that by Acs and Isberg, it is independent of the innovation carried out by the company.

There are various control mechanisms which the company can use to alleviate agency problems arising from the lack of identity between ownership and control in decision-making positions. The economic literature clearly shows the concentration of ownership in the hands of a small number of owners, the incentive involved in giving managers significant shareholdings in the company and the use of debt. For example, the work by Rodríguez (1996) shows how the ownership control mechanism, in its various senses, is evidence of its participation in the conflicts of interest arising in the company, with an even greater importance than a direct shareholding. There is also confirmation of the fact that when ownership is concentrated in few hands, this may lead to more favourable results when carrying out projects of a high risk nature.

Considering the information analysed above, we are now able to specify our objectives. Based on a model which analyses the decision to innovate, we aim to analyse the effects of control mechanisms designed to alleviate possible agency problems on business decisions in the innovation field. Our study will focus mainly on ownership concentration mechanisms, debt financing and the effects related to increases in the shareholdings of owners in decision-making posts. Furthermore, an analysis will also be carried out of the effect of foreign and public ownership of the company's share capital on the decision to incur R & D costs.

⁵ We understand "managerial ownership" to be an aspect showing the percentage of shares or ownership in the hands of managers or directors.

3. METHODOLOGY AND DATA

3.1. METHODOLOGY

Considering that our objective is to analyse the impact of several aspects related to ownership structure and management/control of the company on the decision to innovate, the underlying model in the empirical analysis to be carried out is the one produced by Geroski (1990).

Geroski's model (1990), which was later included in other articles (Crépon et al., 1996; Love et al., 1996), is a logistic model which relates market structure and innovation, based on the following function:

$$I_i = \beta_0 + \beta_1 \pi_i^e + \beta_2 M_i + \beta_3 S_j + \beta_4 Z_i + u$$

where

$$\pi_i^e = \alpha_1 M_i + \alpha_2 S_j + \alpha_3 Z_i + \xi$$

dependent variable I is a continuous unobservable variable (the company innovates if the variable is positive); π^e is the anticipated benefit from innovating, M is the company's degree of monopoly, S is a vector of market structure variables and Z is a vector of company structure and factors influencing the company's ability to innovate.

The amount of π^e is an expectation, meaning that it is not directly observable, although in balanced conditions, maximising of profits may be defined as a function that depends on the company's market power, and on the industry's and company's internal characteristics.

If the function of anticipated profits is input in the investment function, we obtain a function in which all explanatory variables are observable, including both the direct and indirect effects of the explanatory variables:

$$I_i = \lambda_0 + \lambda_1 M_i + \lambda_2 S_j + \lambda_3 Z_i + m$$

$$(\lambda_1 = \alpha_1 \beta_1 + \beta_2, \lambda_2 = \alpha_2 \beta_1 + \beta_3, \lambda_3 = \beta_1 \alpha_3 + \beta_4)$$

Because of the wide range of explanatory variables (many of which may be qualitative), the author has chosen to give the dependent variable the form of a dichotomous variable, which has a value equal to the unit if the company innovates and a null value if it does not. This work will be the basis for the first of the models that will be estimated in this study.

As a result, given the binary nature of the endogenous variable for analysis, the decision whether or not to invest in innovation, specifying a discrete choice model is considered appropriate, selecting the logistic model estimated using the maximum likelihood method. Due to the fact that in this type of model the first order conditions are not linear, the estimated parameters are obtained using iterative procedures. While the parameters are not easy to interpret, their sign shows us the direction of the effect caused by the explanatory variable on the endogenous variable⁶. In this type of model, the quotients between the estimated values of two parameters measure the relative importance of the effects that the explanatory variables associated with these parameters have on the probability of selecting the $Y_i=1$ alternative. Because of this property, while the coefficients of a logit model are not directly interpretable, their relative values are.

Taking into account the theoretical model mentioned above and the hypotheses that we aim to test, the next step is to analyse the variables found to be relevant for our analysis. As a dependent variable, the innovation input variable INNOV is a dichotomous variable that takes the value of 1 if the company has incurred some R & D expense over the year, and a null value if not.

Considering the objectives stated in the previous section, in order to analyse the impact that the various control mechanisms may have on the company's innovative activity, our study has included the following ownership structure and control variables. The variable SHARE includes information regarding the level of concentration of ownership, showing the percentage of the company's share capital that is in the hands of another company or group. The variable OWN is the percentage of owners or family members in management positions in the company's total staff as of 31st December in the year analysed. The variable DEBT is the percentage of financing with debt compared to the company's total financing. As far as information concerning the type of control is concerned, we consider two variables, EXT and PUB. The first includes the percentage shareholding by foreign capital either directly or indirectly (through a company that is more than 50% controlled by foreign shareholders), and the variable PUB is the percentage of direct or indirect public shareholding (through a company that is more than 50% controlled by public shareholding). The variable showing the effects of the corporation is the variable FORM,

⁶ For a more detailed explanation of the logit model, see Econometrics manuals such as those by Novales (1993) or Greene (1998).

a categorical variable which classifies companies according to their legal status - single-member company, limited company, public limited company, worker-owned limited company, workers' co-operative and others. The variable STOCK is a dichotomous variable, which takes the value of the unit when the company is quoted on the Stock Exchange, and a null value when it is not. Furthermore, a range of variables regarding the company's internal structure is considered to check the effect that its general characteristics may have on its innovation. These aspects have been widely analysed in the literature. Problems of bias are thereby avoided in the coefficients of the variables related to the company's ownership structure, which are the main focus of this study.

As far as the company's internal structure variables are concerned, the variable SIZE, a variable showing the size of the business, includes the total personnel numbers as of 31st December. The variable AGE, the variable showing the company's age or maturity, shows how many years have passed since the company was founded. Finally, the variable OPORT⁷ shows information regarding its business sector, and is a categorical variable classifying companies according to the level of technological opportunity in the business sector to which they belong, in sectors of low, medium or higher opportunities.

Like the models mentioned above, in order to include the effect of the structure of the market in which the company works, the variable MARKET has been included, which provides information regarding the geographical extent of the main market. Companies are classified according to whether their market is local, provincial, regional, national or foreign in nature.

Having commented on the variables to be included in our model, it is shown below:

$$\text{INNOV}_i = \beta_0 + \beta_1 \text{SIZE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{OPORT}_i + \beta_4 \text{FORM}_i + \beta_5 \text{STOCK}_i + \beta_6 \text{SHARE}_i + \beta_7 \text{OWN}_i + \beta_8 \text{DEBT}_i + \beta_9 \text{MARKET}_i + u_i$$

(Model 1)

⁷ The following have been classified as high technological opportunity sectors: office machinery, computer, processing, optical and similar equipment; chemical products; machinery and mechanical equipment; electrical and electronic machinery and material; motors and autos; other transport material, publishing and graphic arts. As medium technological opportunity sectors: the meat industry; food and tobacco products; beverages; rubber and plastics; non-metallic mineral products; Metallurgy; metal products. And as low technological opportunity sectors: Textiles and clothing, leather and footwear, wood; Paper; Furniture and other manufacturing industries.

3.2. DATABASE⁸

The database used is the Survey of Entrepreneurial Strategies (*Encuesta sobre Estrategias Empresariales*, henceforth ESEE) produced by the “Public Enterprise Foundation” of Spain for what is today the Ministry of Science and Technology (previously the Ministry of Industry and Energy). The Public Enterprise Foundation's Economic Research Programme designed the survey, supervises its annual production and maintains the database. The ESEE is a statistical research project that surveys a panel of companies representing manufacturing industries in Spain on an annual basis. Its design is relatively flexible and it is suitable for two types of potential use. On the one hand, it provides in-depth knowledge and analysis of the industrial sector's evolution over time by means of multiple data concerning the business and decisions of companies in the sector. The ESEE is also designed to generate micro-economic information that enables econometric models to be specified and tested.

As far as its coverage is concerned, the reference population of the ESEE is companies with 10 or more workers in what is usually known as manufacturing industry. The geographical area of reference is Spain, and the variables have a timescale of one year. One of the most outstanding characteristics of the ESEE is its representativeness. The initial selection of companies took place by combining thoroughness criteria and a random sample. Companies with more than 200 workers were included in the first group, which were requested to participate thoroughly. The second group was formed by companies with between 10 and 200 employees, which was selected by stratification sampling, proportional with restrictions and systematic with a random start-up. This is a random sample of the crosses of the 21 CNAE manufacturing activities to two digits and for employment intervals: 2-10, 21-50, 51-100 and 100-200 workers. The ESEE has data available for Spanish companies since 1990.

Once the variables were presented, and in order to place the information within the framework that we are going to use in our study, we considered it useful to give an initial idea that regarding the variables that will be used in the years under consideration (Tables 1 and 2)⁹. Table 1 shows some statistics describing the quantitative variables in the study. It can be seen that the average concentration of capital in the hands of few shareholders (SHARE) increases

⁸ For more information concerning the database, see Fariñas and Huergo (1999), Fariñas and Jaumandreu (1994, 1999).

with time, while its dispersion also increases. This means that it can be concluded that some companies decided to move from more diffuse controls to more effective controls as a possible control mechanism in the face of agency problems between ownership and control. It can also be seen that over time, there is an increase, albeit a slight one, in the percentage of foreign shareholding, i.e. foreign-owned shares have an increasing influence in the share capital of Spanish companies, which may also have an effect on their business results. However, it can be seen that percentage of public shareholding decreases overtime, due to the privatisation processes undergone in recent years in the Spanish economy. As regards the variable OWN, the variable which shows identity between ownership and control, it can be seen that it seems to have experienced a decline in the percentage of owners in control positions. It should be remembered that this variable may not entirely explain what we are trying to measure, as it may be that everybody who has shares in the company is being considered. In fact, one of the control mechanisms to prevent agency problems is to provide the manager with part of the company's shares, to establish a link between management and ownership. This link may act on management as a possible motivation, so that it may act according to similar criteria to those on which the owner would act, i.e. trying to carry out profit maximisation without incurring in over-investments or investments that are too risky and may endanger the company's health. Finally, the variable DEBT, which includes the percentage of external financing compared to the total financing, undergoes a slight increase with time. As far as the average size and age of the companies considered is concerned, these are medium-sized companies (with an average of 278 workers), which have been stable with the passing of time, and which have an average age of 23 years.

As far as variables of a qualitative nature are concerned, as a prior analysis to the estimation of the model, Table 2 is added, which shows the percentages of companies that state they have invested in R & D in each category and in the years analysed. The results clearly show on a general scale that companies that do invest in R & D are a small percentage of the total number of companies, although this percentage increases with the passing of time. As a summary of the results of the various variables analysed, with regard to the legal status variable (FORM), the most interesting results are the differences between the categories. The

⁹ The years 1994 (number of available observations: 1869) and 2000 (number of available observations: 1754) have been selected because they were at the beginning and the end of the years sampled which contain all the necessary

categories with the highest percentage of R&D costs are “Joint stock companies” and “workers co-operatives”, and a large increase in the percentage of the latter category between the two years analysed can be seen. This type of legal status presumably has a separation between ownership and control because of the great dispersion of ownership, and as Jensen (1986) argued, administrators' behaviour tends towards reinvestment of the resources generated rather than returns to shareholders. When the two years analysed are compared, the reduction of the percentage in the "single-member company" category is significant. This is not the case with the other categories, which increase their percentage in the year 2000.

With regard to the variable which tells us whether or not the company is quoted on the Stock Exchange (STOCK), it is significant that practically all the companies quoted on the Stock Exchange invest in innovation. This result which seems to tell us that this variable may be determinant for companies if they have R & D costs. As anticipated, for the technological opportunity variable (OPORT), the category showing the highest percentage of investment in R & D is the category "high technological opportunity", with half the companies in this category having R & D costs. When the two years analysed are compared, there is an increase in the percentages for all categories of the variable. Finally, the table shows the analysis for the geographical extent of the main market (MARKET). It can be seen how as the extent of the geographical market increases, the percentage of companies making an investment in innovation increases. When the two years are compared, we can see that an increase does not take place in all categories of this variable, as occurs in all the other variables analysed in the table. In the widest-ranging geographical categories, "Spain", "foreign" and "Spain and abroad", instead of an increase in the percentage, which should in principle be anticipated, there is a decrease.

Finally, Tables 3 and 4 shows the correlation matrices between the variables considered in our model for the two years analysed, with the lack of problems of high colineality between them clearly visible.

4. RESULTS

variables for our study.

Tables 5 and 6 show the results from the estimation of the logistical model which explains the decision to incur R & D¹⁰ costs for the years 1994 and 2000 respectively. The main factor is the important explanatory role of the variables of ownership structure and control type in companies' innovative activity.

All the variables that we have defined as variables in the company's internal structure are significant for the two years studied, providing the same conclusions. As was to be expected, both size (SIZE) and age (AGE) presented a positive parameter, leading to the conclusion that the bigger and older the company is, the more likely it is to incur R & D costs. This result is in line with those obtained by many authors. With regard to the size variable, the study by Schumpeter (1942) suggested this influence of size on this type of analysis. There are theoretical works which argue that larger companies have potentialities such as obtaining economies of scale, decreased risk, a larger market and greater opportunities for appropriation (Fernández, E., 1996). Despite the unanimity of the theoretical works, from the empirical point of view there is a great deal of disparity in results. There are both studies with a positive result in the relationship between size and innovation (Scherer, 1992; Scherer and Ros, 1990; Love et al., 1990; Cohen and Klepper, 1996; among others), and others that have not been able to confirm this positive influence of size (Mansfield, 1964; Acs and Audretsch, 1991; among others). For the case of Spain, there are many studies that have aimed to confirm the effect of the size variable on innovation (Labeaga and Martinez-Ros, 1994; Gumbau, 1994, 1997; Molero and Buesa, 1996; Fariñas and Huergo, 1999; Beneito, 2001, 2002; among others) which have reached the same conclusion as Schumpeter, especially in the industrial sector. The age variable (AGE) was also one of the most checked determinants by the literature, with the conclusion drawn by us reached on most occasions.

With regard to the variable concerning technological opportunity in the sector (OPORT), it can be seen how those companies with a low technological opportunity have a lower probability of carrying out R & D than those in the base category¹¹ (medium technological opportunity). On

¹⁰ The selection criteria for the base category in the categorical variables focused on selecting the category with the most frequency. Hence for the variable of legal status (FORM) the category "Limited Company", was chosen, while for technological opportunity of the sector, (OPORT), it was "medium opportunity". For the variable of whether or not the company was quoted on the Stock Exchange (STOCK) the category "not quoted on the Stock Exchange" was chosen, and for the main market (MARKET) "Spain" was chosen. It will be determinant for the study to remember these categories as using the Odds-ratio we can see whether there is a higher or lower probability of investing in R & D or patenting comparing the other categories with the category chosen as the base.

¹¹ For the purposes of interpretation, it should be remembered that the Odds-ratios of each of the categories should be interpreted with regard to the category selected as the base fixed in the unit. Consequently, an Odds-ratio of more than

the other hand, in a result which was to be anticipated, those with greater technological opportunities have a higher probability of incurring R & D expenses. Many authors have also obtained the same conclusions - belonging to a business sector with a high level of technological complexity is a determinant when innovating (for example, Coronado and Acosta, 1999; Gumbau, 1994, 1997; Scherer, 1965; Cohen and Levin, 1989; Paricio, 1993; Kraft, 1989).

As far as the variables of ownership structure and control are concerned, we saw that all legal statuses other than limited companies have a lower probability of incurring R & D costs. However, it should be remembered that the categories of "Workers incorporated" and "workers co-operatives" and "others" are not significant in either of the years analysed. One possible explanation for this may be found in the characteristics of these legal statuses, which include larger companies which mostly have a disperse ownership. These factors may be influencing the decision to carry out investment in R & D.

Looking at the variable which states whether or not the company is quoted on the Stock Exchange (STOCK), it can be seen that this is not significant in 1994. However, in the year 2000, when it is significant, its Odds-ratio shows us that companies quoted on the Stock Exchange have almost double the probability of incurring R & D expenses than companies that do not.

The variable showing ownership concentration (SHARE), is significant and has a positive parameter, meaning that the greater the concentration of capital in the hands of few people, the higher probability of incurring R & D costs. We consider that companies in a position of effective control (we understand a situation of effective control to be the largest homogenous group of shareholders possessing at least 50% of shares) have a higher probability of carrying out investment in R & D. This higher concentration may be acting as a mechanism to relieve agency problems arising from the lack of identity between ownership and control. This is a result that may corroborate some studies for the Spanish case, which attempts to measure the effect of concentration of ownership of Spanish companies on their results.

The variable showing identity between ownership and control (OWN) tells us that the greater the percentage of owners or relatives in management positions with regard to the total number of employees, the lower the probability of R & D being incurred. This is showing us that

1 would imply that a slight increase in this variable has an effect, greater than that of the base category, on the probability of a company deciding to invest in R & D.

the fact that there is an identity between ownership and control makes the probability of incurring R & D costs decline. As pointed out by Rodríguez (1996), the separation between the functions of ownership and management, as well as the appearance of widely diffuse ownership structures (the introduction of other businesses in the company's shareholding) are phenomena that are easy to prove in the vast majority of companies at present (as in the limited company legal status mentioned previously). This separation of functions implies a series of advantages, mainly of specialisation, which businesses cannot ignore. In their study in 1976, Jensen and Meckling noted that there was a problem of free-riding, according to which given the information that investors have on the company's activities is usually limited or not precise, they may have the incentive to involve the company in growth rates above optimal levels instead of trying to maximise its market value, as noted by Jensen (1986). When directors are the people controlling this type of resource, there is the risk of an unproductive or inappropriate use of resources. The solution to this type of conflict must of necessity involve providing managers with the incentive to distribute these resources as against investing them in projects with a negative net current value. To ensure this type of conduct, the management team has two basic tools at its disposition. Firstly, an increase in financing in the form of debt, which obliges the manager to release the free resources that the company has generated. Secondly, greater control by investors by means of a concentration of ownership (an instrument used in Spanish industry, as we have seen) which acts as a supervision mechanism for the poor use that management may make of these resources. In this latter case, managers' shareholding in the company may also contribute to putting a stop to sub-optimal investment policies.

The variable for measuring the effect of the financing mechanism in the form of debt used to control investment activities carried out by the manager (DEBT) does not appear to be a significant variable in the decision to carry out investments in R & D. Our results are in agreement with some authors who argue that financing with debt has an ambiguous effect as a mechanism for mitigating agency problems (Hall, 1992; Chiao, 2002). An increase in the level of indebtedness may lead to increased conflict between shareholders and bondholders. However, this increase may mitigate the divergences of interests between internal and external shareholders and management, as well as providing valuable information regarding business perspectives. In line with the previous comment, there are authors who have obtained

conclusions that are similar to ours. Jensen and Meckling (1976) argue that financing in the form of debt leads to the adoption of investment projects with excessive risk. According to them, the contribution made by shareholders to the company has limited responsibility, so that shareholders prefer management to adopt risky investment projects which offer the opportunity to obtain higher profits and in which the increased probability of loss only affects the holder of the debt. However, the latter prefer less risky projects enabling surer recovery of the value of their contribution. Among the works dealing with the Spanish situation, that by Azofra et al. (1995) obtains a negative relationship between indebtedness and the valuation ratio. It can be seen in this study how those companies with intangible assets or good opportunities for growth, and a consequence, higher valuation ratios, tend to resort to debt to a lesser extent. It can also be seen how a positive valuation by the market is synonymous with a high capacity of internal resources which therefore enables external financing to be dispensed with.

Finally, the variable dealing with the geographical extent of the main market in which the company operates (MARKET) shows the effect that the company deciding to expand its market to a wider region may have. This variable includes various questions. Firstly, there is the fact that companies that are classified in the categories of the widest geographical extent (Spain, abroad, and Spain and abroad) are in principle larger and more mature companies. Because of this, we find companies that have a potentiality to incur R & D costs in their internal characteristics (size, years since establishment). This variable also shows the effect of demand on the decision to invest in improving the product, so that product innovations are determinant in this situation¹². In this field, an important role is played by dealing with a wider geographical area. International competition is more diverse and more intense than competition in smaller geographical areas, meaning that internal capacities must be improved by more risky advertising or innovation expenses in order to obtain a safe market share. We can see that this is a significant variable in the two years studied, with the estimated parameters of the categories smaller than Spain (the base category) are negative, and are positive for parameters that are greater (abroad and Spain and abroad). The Odds-ratio presents values parallel to the parameters, i.e. it can be seen how the probability of taking the decisions to incur R & D costs is lower for geographical areas smaller than Spain, while the probability increases as the

¹² This aspect is included in the study by González and Jaumandreu (1998), who study the decision to carry out product innovations for a sample of Spanish companies.

geographical area expands, and is highest for the areas of Spain and abroad and only abroad, with the latter always having the highest probability. This result corroborates the one obtained in other studies, such as those by Gumbau (1997), Geroski (1990), Love et al. (1996) and Mansfield (1981,1986).

In order to provide more detail regarding the analysis of the effect of the type of control on the decision to invest in R & D, a second model has been estimated, in which the variable SHARE has been replaced by two variables which show firstly, the percentage of foreign share capital, and secondly, the percentage of public ownership:

$$\text{INNOV}_i = \beta_0 + \beta_1 \text{SIZE}_i + \beta_2 \text{AGE}_i + \beta_3 \text{OPORT}_i + \beta_4 \text{FORM}_i + \beta_5 \text{STOCK}_i + \beta_6 \text{EXT}_i + \beta_7 \text{PUB}_i + \beta_8 \text{OWN}_i + \beta_9 \text{DEBT}_i + \beta_{10} \text{MARKET}_i + u_i$$

(Model 1 b)

The same results can be seen (Tables 7 and 8) in the two years analysed. The type of control, both foreign (EXT) and public (PUB) are not significant for either of the years analysed. The opposite result is obtained by some authors, such as Buesa and Molero (1996), who carried out a study on a sample of Madrid companies, in which the probability of carrying out innovation was greater in the group of foreign or public-controlled companies. Nevertheless, our result is in line with the one obtained in the work by Dixon and Seddighi (1996), who also did not find any relationship between the type of ownership and business innovation.

An additional comment in this type of models is their high predictive potential. The prediction potential of a model estimated with logistical methodology is carried out by means of what are known as "classification tables", which compare the responses are observed with the predicted responses in the implemented model. There is a high percentage of correct classification in the estimated models, which in all cases is between 76% and 78%.

As a complement, a graph has been produced, comparing the behaviour of the probability of incurring R & D expenses for the two years, using various observation criteria and calculating the normal distribution. Using model 1 as a starting point, a study is carried out of the effect of various variables related to the internal structure and ownership of the company (SIZE, AGE,

SHARE, OWN) on the probability of carrying out R & D. To this end, two companies¹³ are compared which have the same characteristics but which vary in one single comparison criterion. In figures 1 and 2, we compare the probability of innovating for two companies with different sector technological opportunities (OPORT) according to their size and age, respectively.

Figure 1. Probability of investing in R & D according to size.

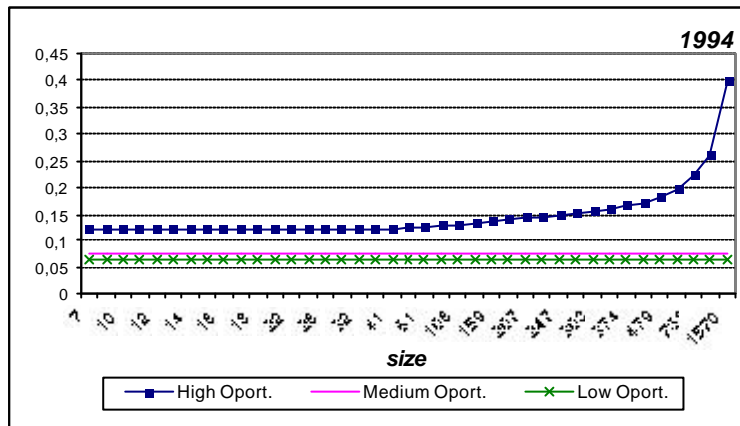
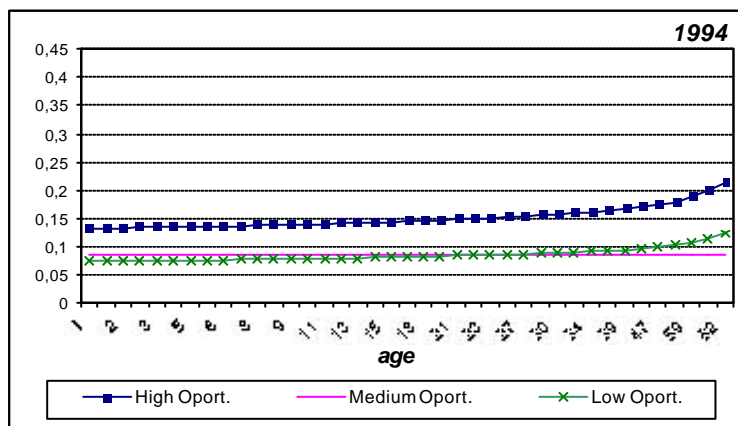


Figure 2. Probability of investing in R & D according to age.

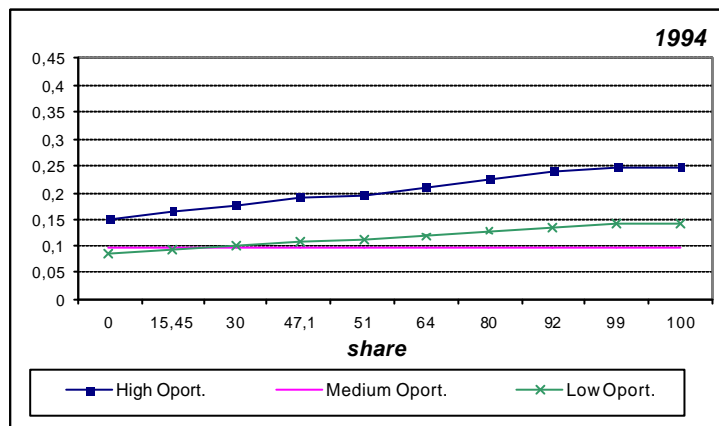


¹³ The company profiles that have been selected have the following characteristics: in the quantitative variables SIZE, AGE, SHARE, OWN and DEBT, the annual average has been chosen as the value (when they were not chosen as a variable for observation). As far as the categorical variables are concerned, the legal status of limited company, quoted on the Stock Exchange and with a main market abroad was chosen. In order to be able to represent the most significant values of the variables to be analysed, the sample was divided into forty groups and their averages were calculated, and these are the values shown on the graph.

As is to be expected, it can be seen that as company size (SIZE) increases, the probability of investing in R & D also increases, although the probability is much greater in the company with a higher technological opportunity. Similarly, as the number of years since the founding of the company (AGE) increases, the probability of investing in R & D increases. The effect of the company's age is greater in companies with high levels of technological opportunity.

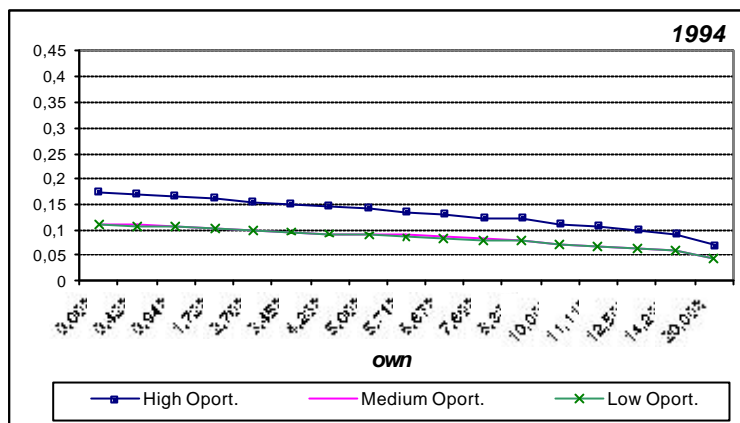
Below, we show a graph of the effect of an increase in the use of control mechanisms on possible agency problems, maintaining the same business profile criteria used in this study of the company's internal variables.

Figure 3. Probability of investing in R & D according to the concentration of shareholding.



As far as a concentration of capital is concerned (figure 3), it can be seen how as this concentration increases, an increase in the probability of investing in R & D takes place. This mechanism has a greater effect in companies with a high level of technological opportunity than in those with lower levels.

Figure 4. Probability of investing in R & D according to owner's participation in decision-making posts.



Finally, a study was carried out observing how increases in the percentage of owners in decision-making posts compared to the total number of employees (OWN) may affect the probability of making investments in R & D (Figure 4). As can be seen, as the percentage increases, the probability of investing in R & D declines. It can also be seen that the effect is greater in companies with high levels of technological opportunity than in those with medium and low levels¹⁴.

5. CONCLUSIONS

This study has tried to analyse the effect that various questions related with ownership structure and control of companies have on their decision to make investments in R & D. It also comes to conclusions regarding the effect of certain control mechanisms used to alleviate possible agency problems arising from the separation between ownership and control may have on the probability of investing in R & D.

As shown in the data, and as noted by various authors (Rodríguez et al., 1994; Alonso and De Andrés-Alonso, 2002) the ownership structure of Spanish companies does not meet the standards of separation between ownership and control and the existence of a large number of small investors, as is the case in the United States. The Spanish case is included within the

¹⁴ While the same graphs have been produced for the year 2000, they are not shown in this work, as the results obtained were very similar, with the same probability profile observed, although with slightly lower values.

European or continental model, in which the concentration of ownership has a mechanism for reducing agency problems predominates.

In view of the results obtained, we can draw some conclusions regarding the use of control mechanisms in resolving agency problems in the administration of business decisions. While this type of mechanism leads to the reduction of agency problems in moral risk arising in informational asymmetries between administrators and shareholders, they may have a number of disadvantages associated with the reduction in action on the part of the administrators.

With regard to the mechanism based on the concentration of capital in a small number of owners, it can be seen that it is one of the mechanisms applied by the company studied. This mechanism has a range of associated disadvantages, related to the increased risk borne by the owners (due to the reduction in their number to obtain greater control levels), less liquidity in markets and fewer opportunities for negotiation of the company's values. As can be seen in our study, it is a mechanism that favours carrying out investments in innovation, due to the higher levels of supervision of administrators' work and the reduction of the problem of opportunism that arises in companies with the future controls. Greater control over administrators leads to an increase in business profitability, because it leads to behaviour that is closer to the maximisation of profits.

The second control mechanism that the study considers is the effect of the inclusion of owners in management and administration tasks. This is a mechanism that aims to alleviate the informational asymmetries that may arise due to the separation between control and administration, with owners assuming administrators' or managers' decision-making tasks. This mechanism moves the company away from the benefits of specialisation. If we therefore consider the importance of specialisation in the context of specific risk of investments in innovation, it can be seen that this mechanism is not the most opportune. Specialisation is on many occasions necessary, in order to have directors with the ability to administer complex organisational structures, diversify risk among shareholders and obtain large volumes of funds to acquire specific assets, as noted by Berle and Means (1932). Decreasing the divergences of interests because of an increase in the number of owners in management positions will make agency costs lower, but risky projects will not be adopted due to the failure to take advantage of specialisation or because there is a high degree of concentration of risk in the hands of a few

owners. As can be seen in our results, an increase in the participation of owners in management positions will lower the probability both of adopting R & D projects and as well as formalising the result of innovation in the Register of patents and utility models.

As regard the third and final mechanism, financing in the form of debt, it can be seen that although around half of company financing is made up of external financing, it is not a significant variable in the decision to carry out investments in R & D. Our result is the opposite to the theories that focus on the influence of debt on the decisions made by managers in the investments made by companies, and are in agreement with the empirical literature, which finds an ambiguity in the application of this mechanism in business investment decisions.

Finally, with regard to the variables that we introduced in our analysis that show the characteristics of the company's internal structure, the anticipated results were obtained. The effect of the size, maturity and technological opportunity in the business sector to which the company belongs is similar to those obtained by other authors who also analyse the innovative activity of Spanish companies. Finally, the market structure variables are important in the analysis, with the influence of competition in business decisions related to the innovative process especially so.

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TABLE 1. Descriptive Statistics

VARIABLE	YEAR	MINIMUM	MAXIMUM	MEAN	MEDIAN	STANDARD DEVIATION
SHARE	1994	0	100	28.10	0	41.21
	2000	0	100	32.29	0	43.09
EXT	1994	0	100	18.47	0	36.72
	2000	0	100	20.02	0	38.46
PUB	1994	0	100	2.20	0	13.57
	2000	0	100	1.39	0	10.50
SIZE	1994	1	13000	278	47	809
	2000	1	15003	279	55	808
OWN	1994	0	100	3.26	0	6.28
	2000	0	50	1.92	0	4.37
AGE	1994	0	264	23	16	23
	2000	0	165	23	17	21
DEBT	1994	0	100	58.34	60.45	23.51
	2000	0	100	59.03	60.88	22.80

TABLE 2. Share of firms undertaking R&D per category

VARIABLE	CATEGORIES	1994	2000
LEGAL FORM (FORM)	▪ "Single-member company"	2.8%	0%
	▪ "Joint stock company"	48.3%	49.0%
	▪ "Limited responsibility company"	10.6%	19.0%
	▪ "Workers incorporated"	20.6%	21.1%
	▪ "Workers co-operative"	28.6%	43.5%
	▪ "Others"	14.3%	20.8%
QUOTED ON THE STOCK MARKET (STOCK)	▪ No	35.4%	37.3%
	▪ Yes	96.9%	98.0%
LEVEL OF TECHNOLOGICAL OPPORTUNITY (OPORT)	▪ Low technological opportunity sector	22.1%	27.2%
	▪ Medium technological opportunity sector	32.4%	33.2%
	▪ High technological opportunity sector	50.1%	50.2%
GEOGRAPHICAL LIMIT OF HIS FIRST MARKET (MARKET)	▪ Local	8.9%	9.7%
	▪ Provincial	11.6%	11.8%
	▪ Regional	16.5%	17.5%
	▪ National	41.2%	38.1%
	▪ Foreign	50.9%	58.4%
	▪ National + Foreign	62.5%	58.9%
TOTAL SAMPLE	▪ % Firms undertaking R&D	36.4%	37.8%

TABLE 3. Correlation Matrix (Year 1994).

	FORM	SHARE	EXT	PUB	MARKET	SIZE	OPORT	AGE	STOCK	OWN	DEBT
FORM	1										
SHARE	-0.295	1									
EXT	-0.234	0.649	1								
PUB	-0.057	0.145	-0.055	1							
MARKET	-0.181	0.326	0.269	0.178	1						
SIZE	-0.122	0.268	0.246	0.279	0.221	1					
OPORT	-0.121	0.240	0.244	0.067	0.117	0.145	1				
AGE	-0.242	0.209	0.190	0.062	0.184	0.210	0.168	1			
STOCK	-0.238	-0.011	-0.001	0.026	0.037	0.155	-0.001	0.154	1		
OWN	0.182	-0.332	-0.257	-0.084	-0.216	-0.166	-0.169	-0.241	-0.036	1	
DEBT	0.065	-0.009	-0.033	0.052	0.019	0.018	-0.082	-0.158	-0.097	0.090	1

TABLE 4. Correlation Matrix (Year 2000).

	FORM	SHARE	EXT	PUB	MARKET	SIZE	OPORT	AGE	STOCK	OWN	DEBT
FORM	1										
SHARE	-0.291	1									
EXT	-0.233	0.619	1								
PUB	-0.024	0.098	-0.026	1							
MARKET	-0.185	0.297	0.280	0.067	1						
SIZE	-0.122	0.267	0.274	0.139	0.163	1					
OPORT	-0.112	0.249	0.219	0.064	0.110	0.149	1				
AGE	-0.261	0.195	0.201	0.069	0.239	0.200	0.156	1			
STOCK	-0.183	-0.025	0.015	-0.005	0.044	0.158	-0.013	0.123	1		
OWN	0.112	-0.296	-0.224	-0.058	-0.166	-0.139	-0.133	-0.124	-0.037	1	
DEBT	0.145	-0.077	-0.069	0.017	-0.054	-0.040	-0.037	-0.244	-0.111	0.060	1

TABLE 5. Model 1: DECISION EQUATION (year 1994)

VARIABLES	CATEGORÍES	ODDS-RATIO	COEFFICIENT	STÁNDAR ERROR	WALD
SIZE		1.001	0.001	0.000	25.944***
AGE		1.007	0.007	0.003	6.522**
OPORT	<i>Medium</i>				23.540***
	Low	0.845	-0.169	0.164	1.053
	High	1.664	0.509	0.135	14.302***
FORM	<i>J. Stock Co.</i>				22.503***
	Single-memb	0.117	-2.142	1.086	3.891**
	Limited-resp.	0.455	-0.788	0.189	17.461***
	Workers inc.	0.721	-0.327	0.461	0.504
	Workers coop.	0.899	-0.107	0.505	0.045
	Others	0.356	-1.032	0.757	1.859
STOCK	Yes	1.663	0.508	0.329	2.394
SHARE		1.006	0.006	0.002	16.488***
OWN		0.006	-5.099	1.832	7.744***
DEBT		0.977	-0.023	0.262	0.008
MARKET	<i>National</i>				52.479***
	Local	0.304	-1.191	0.301	15.622***
	Provincial	0.422	-0.864	0.262	10.885***
	Regional	0.389	-0.943	0.213	19.587***
	Foreign	1.041	0.040	0.239	0.028
	Nat+For	1.444	0.367	0.155	5.606**
CONST	Intercept	0.411	-0.889	0.223	15.870***

***significant at the 0.01 confidence level
 ** significant at the 0.05 confidence level
 * significant at the 0.1 confidence level
 Dependent variable: INNOV
 Base category in *cursive*

Classification table^a

		Predicted		
		Undertaking R&D		Correct share
Observed		No	Yes	
Undertaking R&D	No	927	178	83,9
	Yes	237	419	63,9
Global share				76,4

a. critical value: 0.5

TABLE 6. Model1: DECISION EQUATION (year 2000)

VARIABLES	CATEGORÍES	ODDS-RATIO	COEFFICIENT	STÁNDAR ERROR	WALD
SIZE		1.001	0.001	0.000	23.749***
AGE		1.013	0.013	0.003	17.863***
OPORT	<i>Medium</i>				12.460***
	Low	0.993	-0.007	0.152	0.002
	High	1.514	0.415	0.131	9.943***
FORM	<i>J. Stock Co.</i>				12.019**
	Single-memb	0.005	-5.280	5.648	0.874
	Limited-resp.	0.648	-0.434	0.146	8.908***
	Workers inc.	0.636	-0.453	0.447	1.027
	Workers coop.	1.031	0.030	0.490	0.004
	Others	0.386	-0.951	0.639	2.214
STOCK	Yes	1.939	0.662	0.345	3.680*
SHARE		1.006	0.006	0.001	19.276***
OWN		0.002	-6.250	2.052	9.273***
DEBT		0.905	-0.099	0.266	0.140
MARKET	<i>National</i>				59.299***
	Local	0.315	-1.156	0.315	13.506***
	Provincial	0.391	-0.939	0.253	13.806***
	Regional	0.439	-0.822	0.229	12.914***
	Foreign	1.595	0.467	0.204	5.250**
	Nat+For	1.472	0.386	0.139	7.700***
CONST	Intercept	0.343	-1.071	0.226	22.537***

***significant at the 0.01 confidence level
 ** significant at the 0.05 confidence level
 * significant at the 0.1 confidence level
 Dependent variable: INNOV
 Base category in cursive

		Predicted		
		Undertaking R&D		Correct share
Observed		No	Yes	
Undertaking R&D	No	936	183	83,6
	Yes	267	425	61,4
Global share				75,2

a. Critical Value: 0.5

TABLE 7. Model 1 bis: DECISION EQUATION (year 1994)

VARIABLES	CATEGORIES	ODDS-RATIO	COEFFICIENT	STÁNDAR ERROR	WALD
SIZE		1.001	0.001	0.000	29.650***
AGE		1.007	0.007	0.003	6.689**
OPORT	<i>Medium</i>				25.218***
	Low	0.774	-0.256	0.163	2.475
	High	1.622	0.484	0.134	12.965***
FORM	<i>J. Stock Co.</i>				27.634***
	Single-memb	0.121	-2.113	1.088	3.772*
	Limited-resp.	0.420	-0.867	0.186	21.611***
	Workers inc.	0.613	-0.489	0.459	1.136
	Workers coop.	0.723	-0.324	0.512	0.401
	Others	0.286	-1.253	0.799	2.456
STOCK	Yes	1.441	0.366	0.330	1.230
EXT		1.001	0.001	0.002	0.601
PUB		1.005	0.005	0.005	0.911
OWN		0.001	-6.528	1.857	12.364***
DEBT		1.018	0.017	0.261	0.004
MARKET	<i>National</i>				59.099***
	Local	0.292	-1.230	0.302	16.639***
	Provincial	0.393	-0.935	0.262	12.717***
	Regional	0.365	-1.007	0.214	22.179***
	Foreign	1.023	0.023	0.237	0.009
	Nat+For	1.498	0.404	0.154	6.877***
CONST	Intercept	0.508	-0.676	0.217	9.692***

***significant at the 0.01 confidence level
 ** significant at the 0.05 confidence level
 * significant at the 0.1 confidence level
 Dependent variable: INNOV
 Basis category in cursive

Classification table ^a				
Observed		Predicted		
		Undertaking R&D		Correct Share
Undertaking R&D	No	Yes	No	
No	940	163	85,2	
Yes	235	421	64,2	
Global Share			77,4	

a. Critical value: 0.5

TABLE 8. Model 1 bis: DECISION EQUATION (year 2000)

VARIABLES	CATEGORÍES	ODDS-RATIO	COEFFICIENT	STÁNDAR ERROR	WALD
SIZE		1.001	0.001	0.000	31.206***
AGE		1.013	0.012	0.003	17.064***
OPORT	<i>Medium</i>				14.242***
	Low	0.926	-0.077	0.150	0.267
	High	1.508	0.411	0.131	9.856***
FORM	<i>J. Stock Co.</i>				15.790***
	Single-memb	0.005	-5.227	5.625	0.864
	Limited-resp.	0.614	-0.488	0.144	11.488***
	Workers inc.	0.526	-0.642	0.446	2.070
	Workers coop.	0.835	-0.180	0.492	0.134
	Others	0.324	-1.127	0.653	2.984*
STOCK	Yes	1.697	0.529	0.347	2.314
EXT		1.002	0.002	0.002	1.252
PUB		1.002	0.002	0.006	0.123
OWN		0.000	-7.773	2.109	13.580***
DEBT		0.916	-0.087	0.264	0.109
MARKET	<i>National</i>				65.644***
	Local	0.292	-1.229	0.313	15.403***
	Provincial	0.372	-0.989	0.252	15.354***
	Regional	0.423	-0.861	0.228	14.326***
	Foreign	1.627	0.487	0.204	5.679**
	Nat+For	1.507	0.410	0.139	8.715***
CONST	Intercept	0.425	-0.855	0.219	15.260***

***significant at the 0.01 confidence level
 ** significant at the 0.05 confidence level
 * significant at the 0.1 confidence level
 Dependent variable: INNOV
 Base category in cursive

Observed		Predicted		
		Undertaking R&D		Correct share
		No	Yes	
Undertaking R&D	No	942	176	84,3
	Yes	276	416	60,1
Global Share				75,0

a. Critical Value:0.5