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R&D COMPANIES IN THE IBERIAN PENINSULA: A QUANTITATIVE ANALYSIS OF THEIR SOLVENCY AND PROFITABILITY

Teresa-C., Herrador-Alcaide
Associate Professor
PhD in Economics & Business
Department of Business Economics and Accounting
Faculty of Economics
National University for Distance Education (UNED)
Pso. Senda del Rey 11
Madrid
28040 Spain

therrador@cee.uned.es
+34913986368

Montserrat, Hernández-Solís
Assistant Professor
PhD in Economics & Business
Department of Business Economics and Accounting
Faculty of Economics
National University for Distance Education (UNED)
Pso. Senda del Rey 11
Madrid
28040 Spain

montserrath@cee.uned.es
+34913986368

ABSTRACT

In this paper we present a linear regression analysis of the dependence between the economical solvency variables and profitability (ROA) This is applied to companies that fall within the R&D&I activity sector for 2012. This one has been applied to a statistical sample of more than 1,200 corporations. The study is limited for the companies from the Iberian Peninsula. SABI is the database that`s was used. The objective of this analysis is to determine that solvency can be explained in terms of economic profitability. It was doing the statistical linear regression for each credit category (where "A" is the highest credit category and "F" the worst). Study results support the correlation between variables. It also shows different levels of correlation based on credit rating group.

Keywords: *Iberian Peninsula, R&D industry, Accounting, Solvency Rating, Financial Crisis.*

JEL CODES: *M40, M41, L80*

Introduction

This article examines if the solvency of companies sector R & D can be explained in terms of its profitability. That is, if the variable economic performance is explanatory of solvency. Several groups have differentiated control by category of credit rating. This is carried out a quantitative study based on the technique of linear regression, where the coefficient of linear correlation parameter for the selected drawing conclusions. A test of the null hypothesis of independence between these variables is carried out.

The data source used is the SABI database (Analysis System of Iberian Balances) , prepared by Bureau Van Dijk Electronic Publishing. They selected a sample of more than 1,000 companies that make up the R & D sector (CENAE code). The sample is specific to companies with the legal form of limited liability companies and limited partnerships. The nationality of the companies in the sample was Spanish and Portuguese. Several groups were distinct within the sample based on the credit rating. So, three groups of credit rating were differentiated.

The findings of this research show that into the higher credit rating (more solvent companies) the economic performance is more explanatory than in the companies with a lower rating (more insolvent).

1. Objectives of the study

It is well known that investment makes for the countries in R&D&I is very important for their economical development. The investment for fostering research is the key for a country to be competitive. Despite the current economic crisis, according to data published by the Spanish Observatory for R&D&I, investment in R&D has increased since 2000 during ten years, going from 0.9% of GDP to about 1.3 % (Ine. www.ine.es).

Within the economic system, R&D is carried out both in the public and private sectors. Within the public sector this is done by the research centres. While in the private sector is carried out both by the R&D companies as the research centres. On occasion, the R&D companies provide R&D services to third-parties (another companies), by subcontracting. However, according to the study from (García, 2012), these types of collaboration is not rather widespread, nor in use, as governments prefer to give help for the development of new knowledge rather than pass on what already exist.

In the case of The Iberian Peninsula (Spain and Portugal) there is a business sector that is centred on R&D activities (code CENAE 72) and is set up primarily under the forms of corporations and limited companies. Both two business structures were chosen for this study. The final aim of this paper is to identify if it possible to determinate a statistical correlation between the two economic variables: solvency and profitability. This statistical correlation is analysed for different credit rating. So, the sample is divided in several sub-samples one for each credit rating for 2012 year (last year available in the database). Finally the sample of this study is composed for 1,265 R&D companies which are contained in the SABI database.

For that the investment in R&D to be a competitive advantage for a country, it is necessary that this has a good foundation in scientific research. The countries´ development is almost impossible to achieve without this scientific base (Albert et al, 1994). The measurement of activity in R&D consists of trying to quantify performance, scientific output, bibliometrics and patents in the country technology balance (Sancho, 2012). In the European framework for this are defined a group of indicators, such as the percentage of population with a university degree, participation in lifelong learning or employment in medium-high technology. Much of these indicators are expressed in monetary units, obtained from financial and accounting data (Hernández and Herrador, 2012). The main problem is that one ordinary citizen won´t be able to analyze the position of R&D companies based on the macroeconomic indicators. For this reason it is important to know if it possible to understand if the companies' solvency can be explained by their profitability.

There are empirical studies that show that productivity increases in firms with R&D being greater than in those which less investment in R&D (Máñez et al, 2005). Thus their competitiveness is also greater. In general, it is known that exists a positive relationship between the results obtained by companies and their volume of technological intangible assets, the size of the company and sector being key factors for the volume (Labeaga and Martínez-Ros, 1994) and (Vargas, 2003).

2. Theoretical Framework

Some authors analyze the empirical relationship between the activities of R&D companies and their solvency by the mathematical relationship between both two. So is analysed this relation considering several factors or magnitudes, in order to see if the R&D is in fact a competitive advantage ((Ryan and Wiggings, 2002),(Smith et al, 2002), (Franzen et al, 2007), (Dilling et al, 2009), (Pindado et al, 2010), (Narta and Singh, 2011) and (Li, 2012)). Moreover, many studies delimit a set of ratios which can be considered as variables in models for predicting bankruptcy, many of them based on profits and profitability, since the 70's ((Altman, 1968) and (Bustic, 1994)) until reaching what is currently called IRIS ratios. These ratios are used by regulators in certain sectors to establish minimum levels of equity and guarantee the minimum solvency of the companies (Gaver and Paterson, 2004) because one of the roles of accounting is to provide useful for the various valuation models which are normally used to analyze the solvency (Holthausen and Watss, 2001).

So the focus of this study brings originality to the analysis of creditworthiness of companies in the R&D sector, not considering the R&D as just one activity more of the business. The objective of this study is to analyze the solvency of R&D Iberian companies as a linear function of profitability under the different credit rating obtained. As well as another innovation of this study is that the R & D is studied as a competitive advantage not just for the profitability also for their solvency in this sector.There hardly are any studies which directly analyzing the explanatory mathematical relationship between the solvency of the R&D sector and another economic factors quantified by accounting variables. Therefore, we have focused our study on the analysis of the existence of a linear regression relation explanatory between the solvency and the profitability for Spanish and Portuguese companies of the R & D sector.

The solvency ratio indicates whether a company's cash flow is sufficient to meet its short-term and long-term liabilities. So, if this solvency ratio is considered the dependent statistical variable is being analysing the financial autonomy of the company. Also the profitability variable determines the economic effectiveness of the company to generate income with its available assets (Block and Hirt, 2001). For this is important to determine the appropriate level of solvency / profitability. If R&D is too much, the financial stability is threatened in the short term, but if the R&D is very small, what is jeopardized is the competitiveness of the firm in the long term (Heidenberger et al, 2003). Solvency and profitability are two suitable variables to answer to this question (Sánchez, 1994) because as Rees indicates (Rees, 1990) the ratios are the only analysis tool to enable the comparison among companies.

The crisis of the 80's spurred on development of prediction models for forecasting from Spanish company bankruptcies (Moreno, 1992), by using econometric models that have been developed ad-hoc and previously applied in other countries such as the U.S. (Barniv, 1990). But in addition there are another studies in order to determine the existence or not of correlation between a group of variables and the future solvency in the companies. In this way, in the study from Mora Enguídanos (Mora, 1994) up to 30 ratios based on accounting figures were analyzed, some of them were also used for different types of credit analysis by another statistical method (Segovia et al, 2003). Accounting variables have also been applied to compare companies, allowing to reduce the influence of their size (Gallizo, 2005).

Specifically, there are previous studies based on the analysis of accounting magnitudes which constitute solvency indicators (Sánchez and Ruiz, 2008), but essentially all the studies define a set of ratios as explanatory variables of company financial solvency which may be grouped into three categories that revolve around profit, profitability and borrowings, which are compared by ratio with other significant magnitudes as the solvency. Also, some studies have focused on analyzing whether financial variables coming from accounting magnitudes serve to hedge the solvency risk of the companies ((Joo and Grable, 2004), (Kristensen and Westlund, 2004) and (Aridam, 2006)), applying the regression technique in order to measure the contribution of the accounting variables to inform about the company solvency ((Capstaff, 1991), (Ameur et al, 2008), (Herrador and Hernández, 2013), (Landajo et al, 2008), (Zopounidis and Doumpos, 1998) and (Zopounidis and Doumpos, 2001)).

Among the various factors that influence the development of R&D business (Mei-Ying et al, 2009), this study has focused on solvency, in order to measure its effect on companies in the sector.

3. Empirical Analysis and Methodology

3.1. Sample selection

In this study the selected sample was carried out through several criteria. The first one has been to select companies located in The Iberian Peninsula (Spain & Portugal). Secondly, another criteria was to select by their CENAE code the companies corresponding to R&D sector. And in thirdly from this group in turn, it was made a group by the corporate form of the companies, selecting S.A and S.L. Therefore the sample finally comprises 1,265 companies.

The aim of this research is to analyze the degree of linear dependence between the level of creditworthiness of the company and the profitability. This accounting variable profitability represents the Total Profit before Taxes and Interest on total assets, which indicates the ratio between the company earnings for each monetary unit it has. In order to analyze the level of solvency, the solvency ratio considered is defined as the ratio of total equity to total assets of the company. In this study it is have used the simple linear regression technique. The Pearson coefficient (“r”) has done possible the extraction of the findings. If a value of “r” is near “1” or “-1”, this shall indicate a strong negative or positive correlation respectively and almost a perfect correlation. Thus, the profitability can explain the economic variation for the solvency variable. The coefficient of Determination R^2, allows the linear quantification between the two variables. Its value ranges between "0" and "1". If this is near to "1" this indicates that there hardly is any residual values and that the estimated values with the straight line of regression are mostly coinciding with the actual values. That is to say that the lineal regression model has a good explanatory power. The value of $R^2=0$ shall mean the opposite.

3.2. Regression line

In order to carry out the analysis of the linear dependence between the variable "Y" (solvency ratio) and the variable independent "X" (ROA) is necessary to establish the following Ho:

H_0: r =0
H_1: r≠ 0

This coefficient is determined as $r = \frac{S_{xy}}{S_x S_y}$, where the numerator represents the existing covariance between the two variables and the denominator shows the product of their standard deviations.

Accept Ho would imply that independent variable would not provide meaningful information to the regression analysis. So, accept H_1 would be the otherwise mean.

This analysis was performed for each group of credit rating made. In total were made six sub-samples based on six credit rating offered by SABI. This was made to analyze whether there is a greater correlation between solvency/profitability for higher credit categories (good credit rating)

The regression line obtained with the data is shown by the follow mathematical expression:

$$Y_i = \beta_0 + \beta_i X_i + \varepsilon \qquad (1)$$

Where:

"Y_i" is the dependent variable;

"β_0" is the constant term;

"β_i" is the parameter that measures the influence of the variable and "X_i" on "Y". This is the regression coefficient. If this coefficient is positive, with increasing the value of "X" will also increase the "Y". Conversely, if the coefficient is negative, with increasing the value of "X" will decrease the value taken by "Y". "ε"is the random error that causes the dependence between selected variables.

It is desirable that in the regression model the errors average is close to zero o exactly zero, i.e., E[Є]=0, so the model is formulated as shown below:

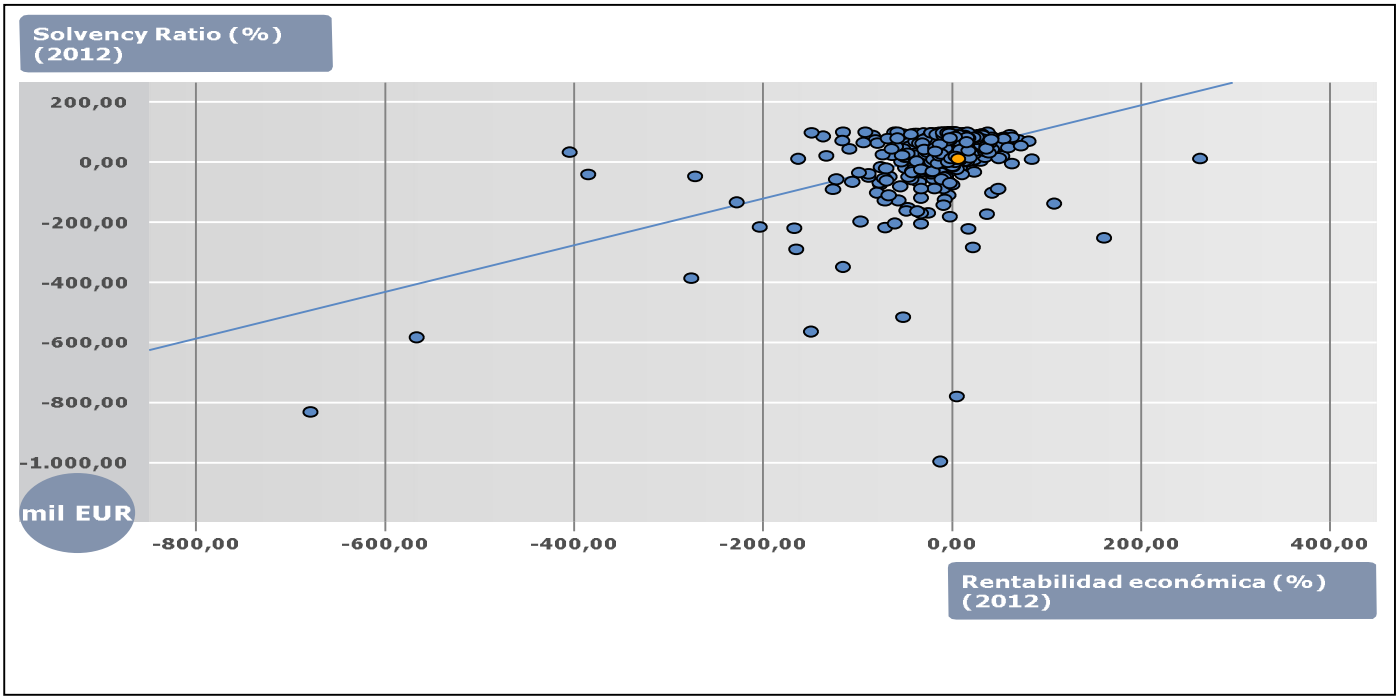
$$Y_i = \beta_0 + \beta_i X_i \qquad (2)$$

3.3. Results of the regression lines

Next, the statistical analysis between the two variables under study will be shown, first without breaking down by credit tranches and after for each one of the six tranches previously defined in Table 1. Therefore it was analysed the statistical correlation between solvency/profitability for R&D sector considering and not considering their credit rating.

3.3.1. General Regression Line (for all credit rating together)

Figure 1: Regression line graph for total Credit Rating



Source: Author using data from SABI

Regression equation: Y= 34.8 + 0.777 X

The value of the linear correlation coefficient r=0.447 shows linear dependence between the selected variables. That is to say, the economic profitability obtained for all companies in the sample without selecting by credit rating, is to some extent explicatory of their solvency level. Almost 45% of the solvency from companies can be explained by their profitability level. So we can assert the existence of an explanatory dependence between the two both variable. The two variables are likely to vary in different proportions but in the same sense, i.e., if the profitability of the company increases, the level of solvency also increases.

However, the overall findings don't indicate what each of the different credit ratings contribute to this linear correlation: what might be the degree to which economic performance is explained from the credit rating. Because we believe that the correlation between the variables for companies with better credit rating can be different than to the others groups with worse credit rating.

Table 1. **Sample Distribution R&D Sector in The Iberian Peninsula**

Risk Levels . Prediction Models VADIS	**ABSOLUTE VALUES**	**PERCENTILE VALUES**
A) Companies with minimum insolvency risk	594	42.64
B) Companies with low insolvency risk	354	25.41
C) Companies with relatively low insolvency risk	193	13.85
D) Companies with medium insolvency risk	107	7.68
E) Unstable companies with high risk of insolvency	82	5.89
F) Top 5% of companies with greatest risk of insolvency	63	4.52
	1393	100.00

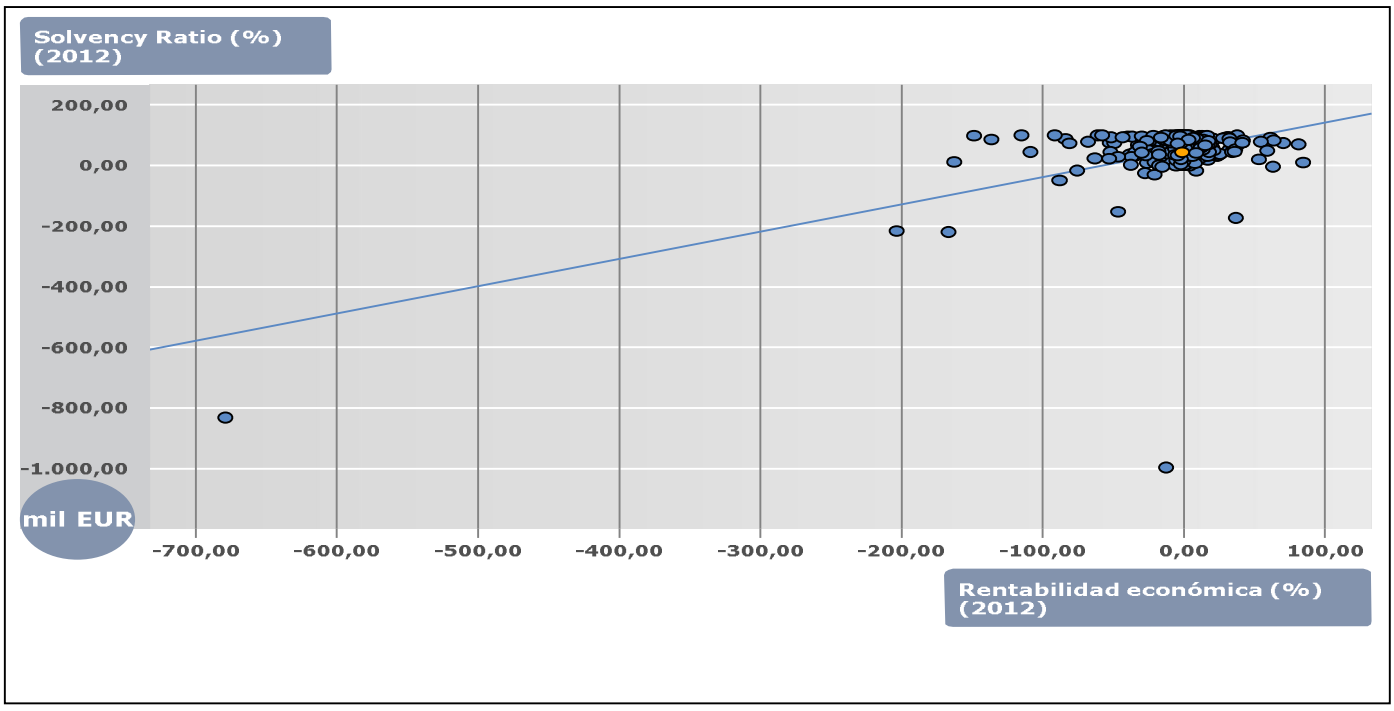
Source: Author using data from SABI

In this way, the sample is divided into six sub-samples, one for each of the credit ratings listed in Table 1, showing below the results of the sub-sample regressions.

3.3.2. Regression line for A-Credit Rating

The regression equation for A is: Y= 52.2 + 0.90 X, with a r=0.511. Its graph is shown in the figure 2.

Figure 2: Regression line graph for Credit Rating A



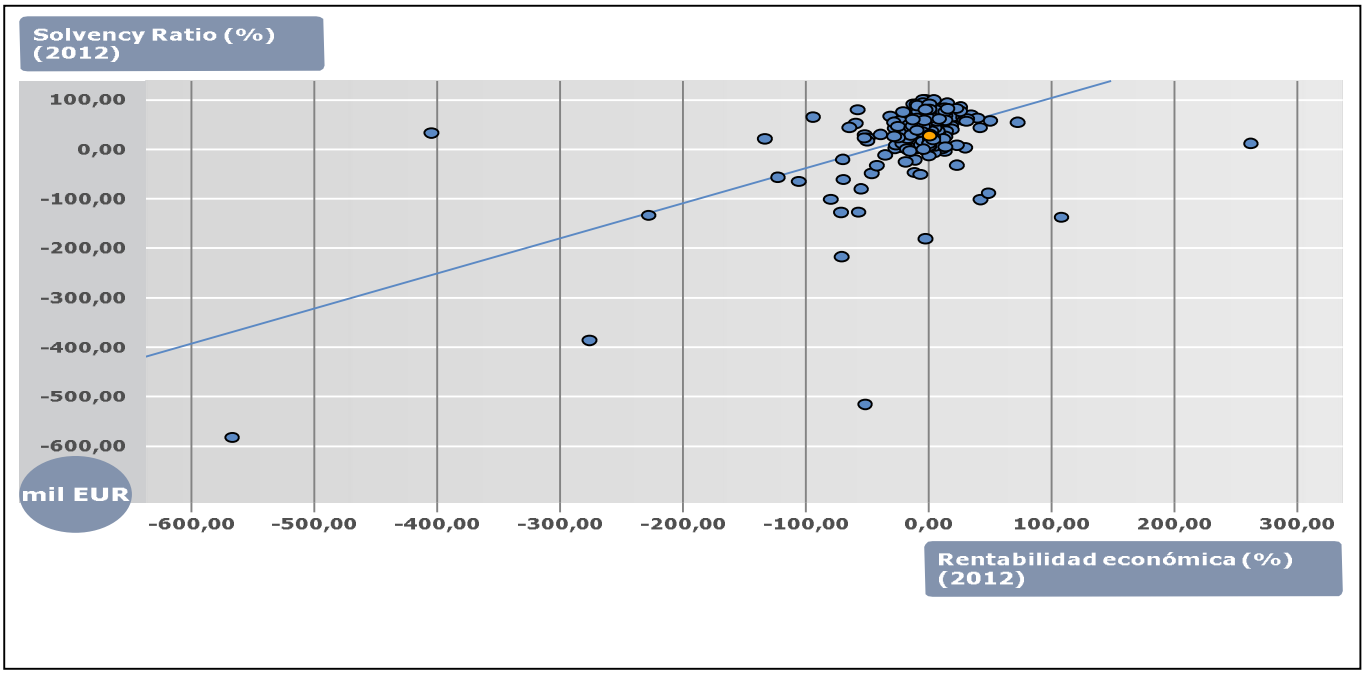
Source: Author using data from SABI

The r=0.511 indicates a linear dependence greater than 50%, i.e., the result of the profitability obtained for the companies with minimal insolvency risk explains the level of solvency for companies in the R&D sector.

3.3.3 Regression line for B-Credit Rating

The regression line is Y= 32.8 + 0.709 X, with a r=0.552, with a lineal plot shown in Figure 3.

Figure 3: Regression line graph for Credit Category B



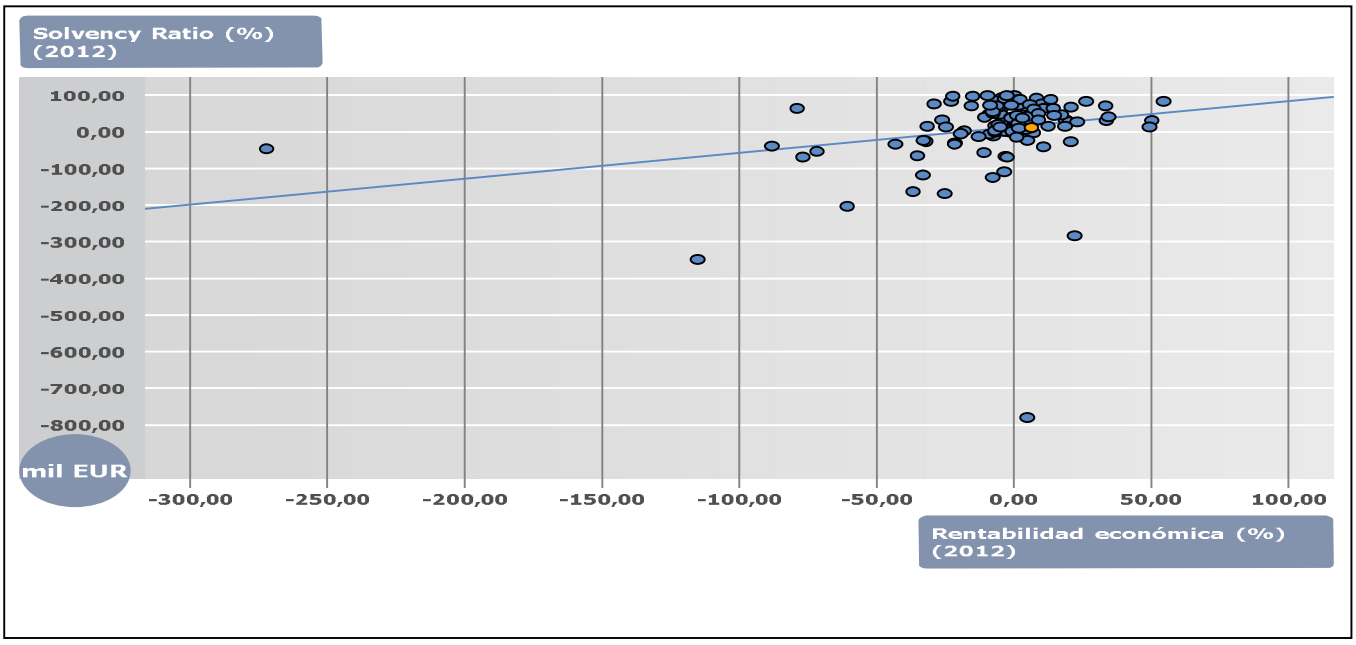
Source: Author using data from SABI

The value of r = 0.552 indicates a positive linear dependence between the variables, i.e., the result of profitability obtained for the companies with low risk of insolvency explains the level of solvency for these companies.

3.3.4. Regression line for C-Credit Rating

For this rating the regression line is represented by Y= 12.8 + 0.704 X, whose graphical representation is shown in the figure 4.

Figure 4: Regression line graph for C-Credit Category



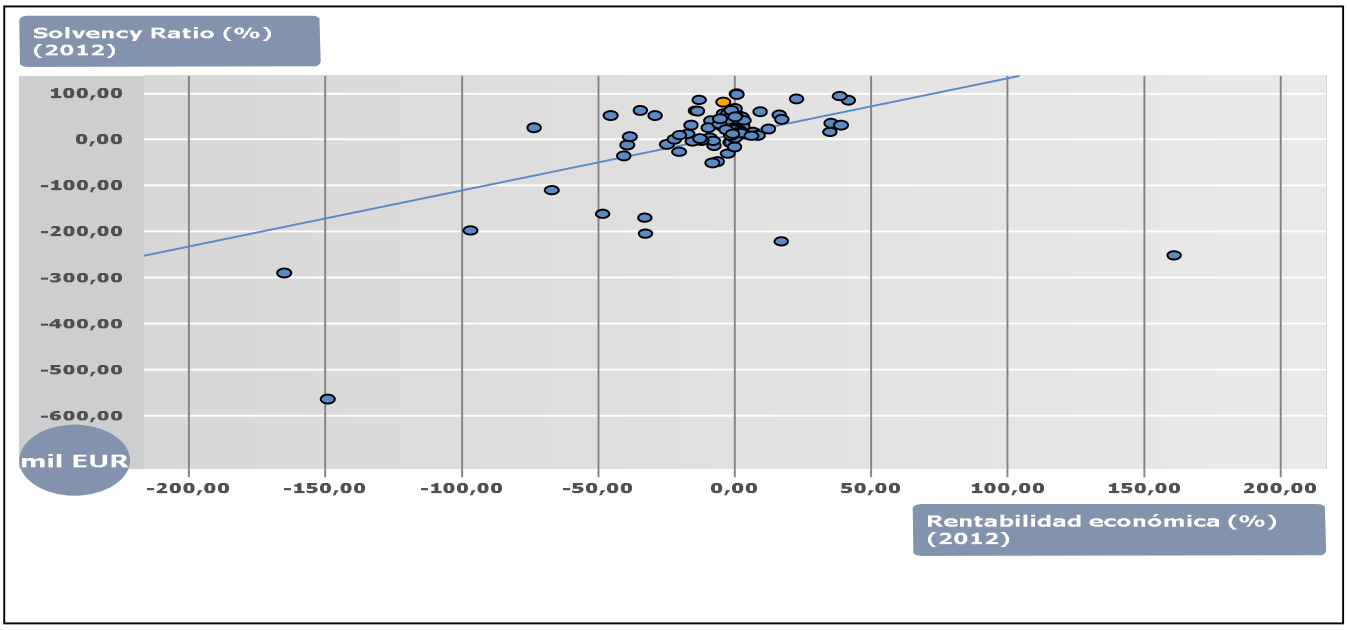
Source: Author using data from SABI

The value take for r = 0.24 indicates a weak linear dependence. The model attempts to relate solvency in a linear way with the profitability presents an almost nonexistent reliability on the lowest category of the selected credit levels. The variables move in the same direction but at different rates, with a very low linear quantification, even though the C-credit category is not the lowest.

3.3.5. Regression line for D-Credit Rating

The lineal regression equation for D is Y= 11.1 + 1.22 X (see figure 5).

Figure 5: Line graph of regression for D-Credit Rating



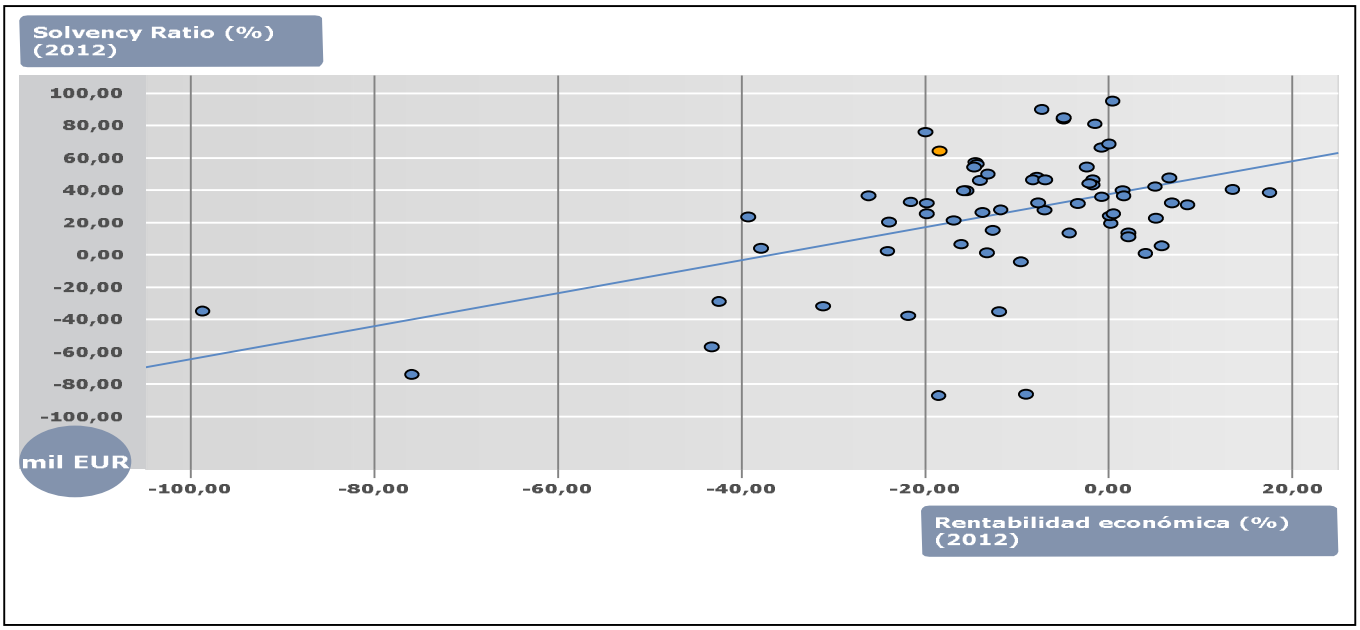
Source: Author using data from SABI

The value of the linear correlation coefficient r = 0.459 indicates a certain linear dependence. The result obtained for these companies with a medium risk insolvency level is explanatory about of 50%.

3.3.6. Regression line for the E-Credit Rating

For this the regression equation is Y= 37.7 + 1.02 X, with r=0.486, which can be seen depicted in figure 6.

Figure 6: Line graph of regression for E-Credit Category



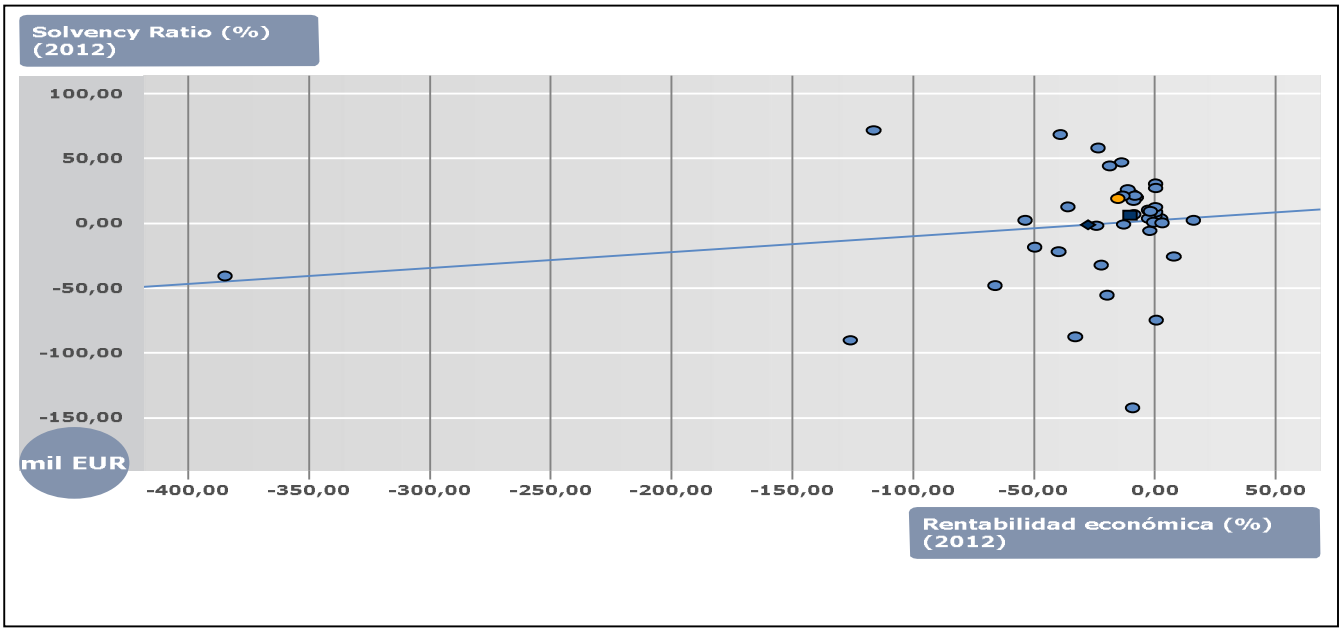
Source: Author using data from SABI

The value of r = 0.486 indicates a linear dependence also less than 50%, as in the other two credit rating.

3.3.7. Line of regression for F-Credit Rating

For the lowest credit rating F, the linear regression equation is Y= 2.15 + 0.122 X, the graphical representation is shown in figure 7.

Figure 7: Regression line graph for F-Credit Rating



Source: Author using data from SABI

In this rating the r=0.182 clearly shows the lack of correlation between solvency and profitability. This is not enough by itself explain the solvency of the organization. The linear quantification in this category is almost zero, i.e., linear independence exists between the two variables.

3.4. Analysis of the regression line coefficients

In order to complete the interpretation of the regression model applied we analyze below the lineal correlation coefficient (r), the lineal determination coefficient (R^2), just like regression coefficient or slope (β_i) and the independent term (β_0). "B_0" is the ordinate in the origin, it is the inclination of the line graph, i.e., it is the increase that occurs in the variable "Y" when the variable "X" increases one unit.

Table 2. Coefficients

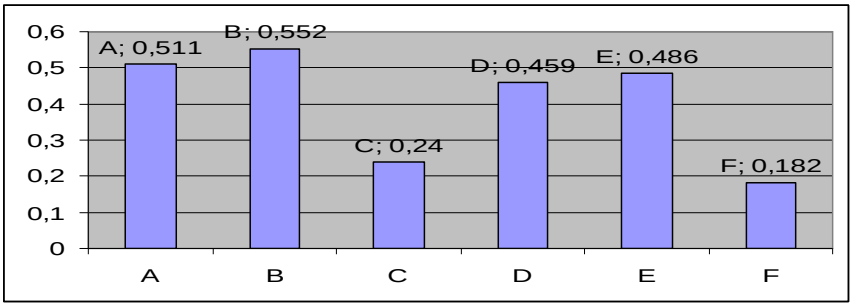
Ratings /Coefficients	B_0	β_i	R	R^2
GLOBAL	34.800	0.777	0.447	0.200
A	52.200	0.900	0.511	0.261
B	32.800	0.709	0.552	0.305
C	12.800	0.704	0.240	0.058
D	11.100	1.220	0.459	0.211
E	37.700	1.020	0.486	0.236
F	2.150	0.122	0.182	0.033

Source: Author

The analysis of the parameters shows for the credit rating of "A" that the increase of value of "X" in one unit entails a increase of 0.777 unit in "Y" from of 34.8, that's the height in which the regression line cuts off at the axis of the "Y" variable. The point of the line at "Y" axis is high in the two best credit categories ("A" & "B"), while in the third rating ("C") is less.

The coefficient value of linear determination is positive in all the credit ratings, but it is worse for the worst credit ratings. In this sense the values obtained for "r" show that solvency can be set in a straight line, with a reasonably good fit to the profitability variable for the two best credit categories, getting worse as it is going to E (see figure 8 for "r" values for credit ratings, not global "r").

Figure 8. "r" coefficient values for credit ratings



Source: Author

Conclusions

The growing demand for social responsibility has not left the R&D sector indifferent to the social impact for a possible insolvency situation. Increasingly, companies must report more financial and economical information to support the transparent of their management.

The R&D activity is one of the main drivers of the economy and promotes activity by means of different resources. Investment in R&D can be made both at the public and private level, but it is the private sector which carries more weight and which has more autonomy in development in general. It is for this reason that in the sample under study the majority of companies belong to the private sector, mainly into the group of small and medium sized enterprises, coinciding with the size of the most of the companies of the Iberian Peninsula.

The analysis has been carried out for the solvency of the companies in terms of economic profitability, and has shown that, depending on the credit rating obtained, the dependency of the two variables varies significantly.

It is observed that R&D companies rated with the highest credit category (A), i.e., the lowest risk of default, their solvency can be explained linearly in terms of profitability, with a level of quantification more than acceptable, continuing this tendency until the credit rating B. This level of linear dependence decreases for the following credit ratings.

Overall, it can be concluded that if the credit rating is lower also the linear correlation between solvency and profitability is lower. So, this results could be interpreted as that when the higher the profitability, the greater the solvency, and this is reflected in the credit rating received by the company and so the economic profitability can be considered as an explanatory variable in the analysis of solvency in high credit ratings (A and B as is shown in figure 8.). Not so for the nearby credit ratings to insolvency where economic profitability variable is not highly influential in the companies' solvency. This finding leads us to ask for upcoming studies the necessity to introduce in this model other explanatory complementary variables.

Despite the obtained results, one limitation of the analysis is the fact of isolating a factor (the profitability) in order to properly study its effect on the solvency variable. Therefore, the value of the correlations is explanatory for the sector and the period studied, but one must be cautious in extrapolating results for a predictive use. It would be interesting to study the one-to-one correlation, between the solvency variable and other variables for the R&D sector in The Iberian Peninsula.

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