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R & D in Greek Listed Companies:

A Test of Prediction Models

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Abstract

Dichotomous analytical techniques such as discriminant analysis and a logit specification have been used to investigate the business decision to spend in Research and Development (R&D) investments. Using these techniques it is shown whether R & D investments can be forecasted, which are the discriminating variables that distinguish companies that have R & D investments from those that do not have R & D investments, and which statistical technique fits better to the data drawn from the companies listed on the Athens Stock Exchange. Results indicate that the above mentioned business phenomenon can be forecasted by 92.9% by logit when one year data before the R & D investment is used.

Keywords: R & D spending, Financial ratios, Discriminant analysis, Logit, Prediction

1. Introduction

In today's innovation-driven economies, Research and Development(R & D) expenditures play a crucial role in determining economic growth and productivity. Holt's legislation, known as the "Create Jobs by Expanding the R & D Tax Credit Act of 2010" in USA is expected that it would temporarily boost the most common form of the federal R & D tax credit, the Alternative Simplified Credit for research and development, by expanding it from 14 to 20 percent. R & D has an experience of a couple of years in the USA and is a recent phenomenon in Greece.

Currently and after the SFAS 2 R & D costs are expensed as incurred. In December 1973 the FASB released a Discussion Memorandum on alternative accounting and reporting practices for R & D costs. An Exposure Draft was followed in June 1974 and finally the publication of Statement No. 2, Accounting for R & D Costs in October 1974 effective for annual reports issued after January 1,1975. The deferral method was much more widely used among smaller companies. In October 1975, it was adopted by the SEC in its Accounting Series Release No. 178.

According to IFRS, R & D costs are capitalized when technical and economic feasibility of a project can be demonstrated in accordance with specific criteria. Some of the technical criteria include: demonstrating technical feasibility, intent to complete the asset, and ability to sell the asset in the future as well as others. Prior to IAS (IFRS) research and development costs were either written off as incurred, or amortized over five years. Although aggregate US industrial R & D spending increased at an average annual-compounded rate of 7%(in real terms) over the period 1979-1984,real growth was only 2% over the subsequent three to four years(Chan et al.,1990).

The usual arguments start with share prices and end with corporate investment spending. They run through earnings. For this reason, R & D spending is of special interest.

Since 1974, research budgets are not depreciated but expensed and therefore pre-tax reported earnings fluctuate dollar-for-dollar with changes in R& D. Executives may adjust R & D to smooth accounting earnings and to signal firm value. They may try to influence investor sentiment. Finally, discretionary adjustments in R & D may also reflect managerial incentives, available funds, debt capacity, and taxes.

Because the phenomenon is very recent in Greece, we first examine the financial characteristics of companies with R & D investments and those that do not have R & D investments. Dichotomous analytical techniques have been employed in order to discriminate the two groups of companies. This paper purports to compare empirical findings drawn from the application of two dichotomous statistical techniques through an assessment of the analytical quality of ratio analysis using data drawn from the Athens Stock Exchange. The rate of companies that have R & D investments is 10.75% (30 companies over 279 companies that report financial statements) and 10.18% for the sample used in this study (28 over 275 companies).

The motivation of the study is focused on the low rate of R & D investments by Greek listed companies and our concern is about the investigation of the particular characteristics that make the two groups of companies (those that have R& D and those which do not have R & D) be differentiated and the concentration of making R & D investments primarily in the food industry and secondarily in the computer services. The contribution of the study is the first evidence provided to the literature as far as the R & D investments as well as the additional evidence concerning the test of prediction models.

The rest of the paper is organized as follows. Next section reviews the literature. Section III contains the research design. Section IV discusses empirical findings. Section V concludes with a summary and suggestions for further future research.

2. Review of the Literature

Horwitz and Kolodny (1980) concluded that the expense-only rule caused a relative decline in R & D outlays for small, high-technology firms which had previously used the deferral method of measurement based on the results of (1) statistical tests of the association of FASB Statement No. 2, Accounting for R & D Costs, with reductions in the level of R & D outlays of affected firms. They based their investigation on a module designed to (1) test whether there was an association between the effective date of Rule 2 and changes in R & D expenditure levels among affected firms and (2) determine the attitudes of the chief financial officers of small, high technology firms (that have an important role in the development of innovative processes) regarding the effect of Rule 2 on R & D outlays. Their results suggest that affected companies reduced their expenditures on R & D.

Elliott et al.(1984) examined any changes from capitalization to an expense of R & D after SFAS 2 showed that the relative expenditures of capitalizing firms declined more than did those of matched expensing firms. Hirschey and Weygandt (1985) dealt with the R & D issue from a market value perspective by determining whether R & D expenditures have a positive effect on the market value of the firm. Their results indicated that R & D expenditures have systematic influences on the market value of the firm that persist over time, and therefore ‘’can be thought of as forms of intangible capital investment providing a basis for determining a relevant range for economic amortization rates’’. While their results suggest a five-to ten-year life, they believe that ‘’further research on the factors affecting these estimates is necessary before sufficient information is available to develop an appropriate accounting policy’’.

Cohen and Levinthal (1989) assert that although economists think of R & D as generating one product(new information),R & D not only generates new information, but also improves the firm’s ability to assimilate and exploit existing information-what they call “learning” or “absorptive” capacity. By considering the implications of this dual role of R & D for the firm’s incentive to invest in R & D they used a model in a consideration of the basic sources of technological knowledge utilized by a firm: the firm’s own R & D, knowledge which originates with its competitors’ R & D spillovers, and knowledge which originates outside the industry. Their empirical results suggest that determinants of the ease of learning, particularly the targeted quality of knowledge inputs affect both appropriability and technological

opportunity conditions. Thus, the characteristics of knowledge may represent an important class of determinants of R & D investment.

Chan et al. (1990) investigating share-price responses to 95 announcements of increased R & D spending found that there is significantly positive relationship on average even when the announcement has to do with an earnings decline. They found that high-technology firms that announce increases in R & D spending exhibit positive abnormal returns on average, whereas announcements by low-technology firms are associated with negative abnormal returns. They found that firms with R & D investments higher than the industry average exhibit larger stock-price increases only for firms in high technology industries. Baber et al.(1991) using data for 438 US industrial companies during the period 1977-1987 investigated whether concern about reporting favorable trends in accounting net income influences decisions to invest in R & D. They found that when R & D spending affects the reporting of positive or increasing income then relative R & D spending (defined as the ratio of current-to prior-period spending) is significantly less. This seems to have affected the competitiveness of US manufacturing. They also examined the possibility of accounting-based compensation arrangements and their results which are inconsistent with the interpretation that only explicit compensation arrangements determine observed differences in R & D spending. Their results are consistent with conclusions that R & D investments have been discouraged by SFAS No. 2.

Wasley and Linsmeier (1992) used daily stock returns for publicly traded and OTC firms from April 1974-May 1976 and measured the mean capital market reaction to the release of SFAS 2 Exposure Draft. Their results indicated that SFAS No. 2 has limited effect on market reaction. SFAS No. 2 may not be a determining factor to the fact that the initial announcement of the accounting change has no significant association with a market reaction along with any subsequent decline in R & D confidence that previously documented. Hall(1993) using all publicly traded firms in the US manufacturing sector that existed in 1976 or entered between 1976 and 1991 used two variables to measure the R & D capital(the first is just the flow of R & D expenditures which is a fairly good proxy for long-run R & D behavior, owing to the low variance of the R & D series within a firm, and the second is an R & D stock that is constructed from past R & D expenditures under the assumption of a depreciation rate of 16 percent per annum). He asserts that ‘’the stock market valuation of R & D capital in US manufacturing firms collapsed rather quickly from a high of 0.8-0.10 during 1979-1983 to a low 0.2-0.3 during 1986-1991’’. In other words, he found that intangible assets from 1973 through about 1983-1984 were about equally valued with tangible capital but this relationship broke down completely during the mid-1980’s.

Lev and Sougiannis (1996) addressed the issues of reliability, objectivity, and value-relevance of R & D capitalization. They estimated the association between R & D expenditures and subsequent earnings by investigating firms with a high R & D intensity cross-sectionally. They provided evidence that there is a significant association between adjusted values and stock prices and stock returns meaning that the R & D capitalization is value-relevant to investors. Bange and Bondt (1998) using a panel of 100 US companies with large R & D budgets for the decade 1977 to 1986 and employing financial analysts’ earnings

forecasts, one-year ahead, as a proxy for the firm's profit targets investigated the ability of earnings management to affect research and development spending directly. They found that managers prepare R & D budgets to make a difference between analysts' forecasts and reported income. Further, they found that R & D spending depends on the availability of funds.

Bushee (1998) examined whether institutional investors introduce lower R & D investments so that managers can meet short-term earnings goals. He examined two competing views: i)the frequent trading and short-term focus of institutional investors encourages managers to engage in myopic investment behavior(Note 1), and ii)the large shareholdings and sophistication of institutions allow managers to focus on long-term value rather than short-term earnings) by testing whether R & D spending is affected by institutional ownership for firms that could reverse a decline in earnings with a reduction in R & D. Results indicate that it is less likely R & D spending to be lower in order to reverse an earnings decline when institutional ownership is high, implying that institutions are sophisticated investors justified with a typical monitoring role in reducing pressures for myopic behavior. Another case is when institutions that have high portfolio turnover and engage in momentum trading they increase the probability that managers reduce R & D to reverse an earnings decline. Mande et al. (2000) argued that Japanese managers may be making suboptimal allocations to R & D spending due to the recent recession period and they tested whether Japanese managers adjust R & D spending based on the firm's performance in the short-term by smoothing earnings.

Chan et al.(2007) using a sample period from 1991 to 2002 tested many hypotheses that turn around the differential long-term market impact of either the expense method or the capitalization method may cause and, thus far, how value-relevant is each one of these two options. They found evidence that given the resources constraint they make investments with a higher return in the future. Their results give credence to the fact that it is the market that leads to the selection of the accounting method (capitalization versus expensing of R & D). Seybert (2010) examined whether the accounting method (capitalization versus expensing) plays a role in the decisions made by managers when they are called to undertake and implement an R& D investment project. He found that managers are more likely to overinvest when R & D is capitalized. He found that reputation which is an aspect of self-monitor is actually a factor that leads to an overinvestment in R & D. Cheng and Su (2010) examined the relationship between R & D spending and the growth rate in sales using data of firms in the electronic industry in Taiwan. They indicated that there is an optimum level of R & D spending. They found that R & D spending is positively associated with sales growth when R & D spending is upper than a threshold and negativily associated when R & D spending is above a threshold.

3. The Research Design

3.1 The Research Method

Discriminant analysis and logistic regression are statistical methods that examine the power of explanatory variables to predict whether individual cases are drawn from one or the other

of two populations. These methods are employed in this study. For both types of analysis, Y is an indicator variable representing making R & D investments or not, with Y=1 if the firm has made R & D investments and Y=0 otherwise. The predictor variables, denoted by a row vector x, include eleven financial ratios for the firm. The two types of analysis are closely related, as will be shown below.

Our model for discriminant analysis assumes that predictor vector x is drawn from one of two multivariate normal distributions corresponding to firms with Y=1 and Y=0, respectively. The research hypothesis postulates that the two populations have different means but the same covariance matrix. A linear discriminant function w=a+xb is formed as a linear combination of the predictor variables. Here a is an intercept and b is a column vector of discriminant coefficients. Because x is assumed to be multivariate normal, the linear discriminant value w is also normally distributed. Under the research hypothesis, the normal distributions for Y=1 and Y=0 have different means but a common variance. Both a and b are estimated from the data in such a way that the statistical distance or separation of the Y=1 and Y=0 samples on the linear discriminant scale is as large as possible. Table 3, shown later, presents results of this estimation procedure and an assessment of the discriminating power of the predictor variables.

Logistic regression considers the probability P(Y=1|x) that a firm with predictor vector x will have opinion Y=1. For brevity, we let p=P(Y=1|x). By definition, the probability that the firm will not have R & D investments is 1-p=P(Y=0|x). The logistic regression model assumes that the log-odds of event Y=1 is the following linear combination of the predictor variables:

$$\log [p/(1-p)]=c+xd$$

Here p/(1-p) denotes the odds in favour of Y=1, c is an intercept term, and d is a vector of regression coefficients that are estimated from the data using the method of maximum likelihood. The model estimation attempts to associate large probabilities p with firms for which Y=1 and small probabilities p with firms for which Y=0. Table 3 presents results of this estimation procedure and tests whether the predictor variables successfully classify firms from the two populations.

The strict statistical assumptions set up by Palepu (1986), Karels and Prakash (1987), Maddala(1991), are: (1) the equal probability distributed between the two groups of companies, and the efficiency of each model using different data; (2) further statistical implications related to the unequal sampling rates; (3) the stability of discrete models overtime.

3.2 Hypotheses Development

In the literature it is refereed that R & D spending is associated with net income. Thus we posit the first two hypotheses as follows:

H_1: companies with R & D are more profitable than companies with no R & D

H_2: making of R & D investments is associated with profitability.

On the other hand, the availability of funds influences R & D spending. So, we assume that either debt or shareholdings (issuance of shares) are associated with making R & D investments. Testing whether institutional ownership affects R & D spending for firms that could reverse a decline in earnings with a reduction in R & D indicates that managers are less likely to cut R & D to reverse an earnings decline when institutional ownership is high, implying that institutions are sophisticated investors who typically serve a monitoring role in reducing pressures for myopic behavior

Thus, the next two hypotheses have as follows:

H_3: Debt ratio (leverage ratio) is associated with R & D

H_4: Equity to debt ratio is associated with R & D

To test the significance of the discriminant function as a whole we develop the next hypothesis (that the two groups have the same mean discriminant function scores).

H_5: the model is discriminating

Finally, we test the predictability, the classification accuracy of the models. So, the hypothesis has as follows:

H_6: classification accuracy is high and making of R & D investments can be forecasted.

3.3 Variables Selection

The variables used are represented by the financial ratios selected in this study. They have been selected in order to have a full picture of the profile of the company and have been employed in other studies. The list of financial ratios used has as follows:

Financial Ratios	Abbreviation
Net Income: Total Assets(return on assets)	NITA
Cash: Current Liabilities(liquidity ratio)	CASCL
Cash: Total Assets(liquidity ratio)	CASTA
Quick Assets: Total Assets(quick ratio)	QATA
Current Assets: Sales(return of current assets to sales)	CASA
Net Worth: Total Debt(equity to debt ratio)	NWTD
Receivables: Inventories(short-term financial ratio)	RECINV
Working Capital: Total Assets(working capital percentage to total assets)	WCTA
Total Debt: Total Assets(leverage ratio)	TDTA
Net Income: Sales(return on sales)	NISA
Sales: Working Capital(working capital turnover)	SAWC

Profitability, liquidity, and leverage ratios as figured out above have been tested and successfully justified as the leading ratios for corporate prediction purposes.

Besides, the following two variables have been selected:

Assets size as measured by the log of assets. Taking the logarithm transforms the highly right-skewed distribution pattern to one that is more symmetrical. Thus, a few isolated firms will be less influential on the statistical fit of the model.

Industry as a categorical variable indicates the concentration of firms with R & D investments in specific industries. In particular, companies in the industries below take the value 1 versus all other companies which take the value 0.

Food, computer services, medical services, petroleum, personal care, publishing and construction materials represent 17 out of 28 companies with R & D investments.

3.4 The Sample Selection

Companies listed on the Athens Stock Exchange have been selected for investigation in this study. The size of the sample is based on the number of firms appeared in the Web site of the ASE for one and two years before the event of R & D commencing with the most recently published data on 2008.The total number of firms that reported financial statements published in the Web site of the ASE is 279 companies for year 2008.Companies which satisfy the presumption of two consecutive years before the event of R & D are 275. Companies with R & D are 30 in the Web site of the ASE and they are 28 in the sample. Companies that have R & D are dispersed in many industries but not so many as in other business events. The greatest share gets the food industry(14.3% of the sample) and other industries like computer services(10.7%),and medical services, petroleum, construction materials, publishing, personal care(7.14% each).

4. Empirical Findings

In a consideration of means of each variable used in the analysis, results are more illustrative of the differences between groups of companies. Companies with R & D and companies without R & D do not present great differences except variables X_6, X_7, and X_{11} when data for one year before the event are used. Obviously, this is an evidence that Net Worth/Total Debt, Receivables/Inventories and Sales/Working Capital will be the most crucial variables in the discriminating process, as well as the predictive ability of models employed in this study. When data for two years(one year before and two years before the event) are used, means differ between the two groups of companies for variables like X_5(Current Assets/Sales), X_7(Receivables /Inventories), and X_{11}(Sales/Working Capital).

H_1 indicate that companies with R & D are a little bit more profitable than companies with no R & D.

Kolmogorov-Smirnov is an appropriate statistic to test normality. It is of high importance to test normality because outliers may have a big influence. Prior studies have shown that non-normally distributed financial ratios are characterized with the presence of outliers. Worthnoting that we have a great number of outliers in variables RECINV (Receivables /Inventories) and SAWC(Sales/Working Capital).Note that the number of outliers is very small in other studies when the matter of the distributional properties of financial ratios is examined (Deakin,1976;So,1987; Karels and Prakash, 1987).

Table 1. Average Ratios (Means)

	ALL DATA			OUTLIERS EXCLUDED		
	R & D	NO R & D	Signif.	R & D	NO R & D	Signif.
Panel A: One Year Before						
NITA	2.509E-02	-1.78E-02	0.773	3.286E-02	-1.78E-02	0.773
CASCL	0.299	1.35	0.829	0.251	0.661	0.638
CASTA	0.127	9.286E-02	0.942	0.177	9.286E-02	0.942
QATA	0.543	0.514	0.401	0.587	0.514	0.401
CASA	0.994	1.827	0.637	0.375	1.202	0.553
NWTD	1.037	3.355	0.856	0.714	0.896	0.559
RECINV	2.937	112.333	0.404	5.684	2.527	0.205
WCTA	0.193	0.163	0.823	0.254	0.163	0.823
TDTA	0.806	0.763	0.838	0.844	0.763	0.838
NISA	1.452E-03	-0.240	0.886	-3.37E-02	-5.35E-02	0.802
SAWC	2.515	-1.146	0.189	3.373	1.795	0.106
Logassets	5.388	5.187	0.160	5.401	5.187	0.160
Industry	0.607	0.000	0.000	0.607	0.000	0.000
Panel B:Two Years Before(one and two)						
	ALL DATA			OUTLIERS EXCLUDED		
	R & D	NO R & D	Signif.	R & D	NO R & D	Signif.
NITA	2.508E-02	8.945E-0	0.248	2.508E-02	8.945E-03	0.248
CASCL	0.299	0.377	0.888	0.299	0.453	0.831
CASTA	0.127	8.447E-02	0.729	0.127	8.447E-02	0.729
QATA	0.543	0.464	0.681	0.543	0.464	0.681
CASA	20.991	1.285	0.824	1.214	1.611	0.977
NWTD	1.037	0.970	0.559	1.037	1.146	0.237
RECINV	9.123	2.536	0.103	5.344	3.500	0.253
WCTA	0.193	0.171	0.908	0.193	0.171	0.908
TDTA	0.806	0.667	0.947	0.806	0.667	0.947
NISA	1.474E-03	3.910E-02	0.273	1.474E-03	-0.103	0.208
SAWC	3.056	1.822	0.093	2.981	1.753	0.090
Logassets	5.388	5.178	0.047	5.371	5.178	0.047
Industry	0.607	0.000	0.000	0.607	0.000	0.000

Table 2. Normality Test (Kolmogorov-Smirnov)

	ALL DATA		OUTLIERS EXCLUDED	
	R & D	NO R & D	R & D	NO R & D
Panel A: One Year Before				
NISA	2.251(0.000)	3.766(0.000)	2.026(0.001)	3.766(0.000)
CASCL	2.356(0.000)	6.753(0.000)	1.502(0.022)	6.652(0.000)
CASTA	2.840(0.000)	4.426(0.000)	2.001(0.001)	4.426(0.000)
QATA	2.566(0.000)	4.167(0.000)	1.786(0.003)	4.167(0.000)
CASA	1.480(0.025)	5.440(0.000)	1.691(0.007)	4.435(0.000)
NWTD	2.028(0.001)	6.569(0.000)	0.750(0.627)	3.513(0.000)
RECINV	1.421(0.035)	6.771(0.000)	1.203(0.111)	2.472(0.000)
WCTA	2.428(0.000)	3.731(0.000)	1.967(0.001)	3.731(0.000)
TDTA	2.931(0.000)	5.237(0.000)	2.241(0.000)	5.237(0.000)
NISA	1.954(0.001)	5.915(0.000	1.893(0.002)	4.560(0.000)
SAWC	0.935(0.346)	6.271(0.000)	1.013(0.256)	1.493(0.023)
Logassets	1.057(0.214)	1.493(0.023)	0.774(0.587)	1.493(0.023)
Industry	1.057(0.214)	- -	2.076(0.000)	- -
Panel B:Two Years Before(one and two)				
	ALL DATA		OUTLIERS EXCLUDED	
	R & D	NO R & D	R & D	NO R & D
NITA	2.252(0.000)	5.197(0.000)	2.252(0.000)	5.197(0.000)
CASCL	2.355(0.000)	5.197(0.000)	2.355(0.000)	7.910(0.000)
CASTA	2.841(0.000)	5.947(0.000)	2.841(0.006)	5.947(0.000)
QATA	2.566(0.000)	5.135(0.000)	2.566(0.000)	5.135(0.000)
CASA	3.704(0.000)	6.145(0.000)	2.175(0.000)	7.009(0.000)
NWTD	2.028(0.001)	4.693(0.000)	2.028(0.001)	5.801(0.000)
RECINV	2.033(0.001)	3.325(0.000)	1.828(0.003)	4.375(0.000)
WCTA	2.427(0.000)	4.701(0.000)	2.427(0.000)	4.701(0.000)
TDTA	2.931(0.000)	6.411(0.000)	2.931(0.000)	6.411(0.000)
NISA	1.953(0.001)	6.538(0.000)	1.953(0.001)	8.518(0.000)
SAWC	2.098(0.000)	1.965(0.001)	1.146(0.145)	3.294(0.000)
Logassets	1.057(0.214)	2.073(0.000)	1.146(0.145)	2.073(0.000)
Industry	2.952(0.000)	- -	2.952(0.000)	- -
Numbers in parenthesis indicate two tails significance				

The choice of the best fitting model is stressed through a discussion of all empirical findings drawn from a test of discriminant and logit analysis. In each year, a company is observed in one of two alternative states. Coefficients for each model and for each variable in one and two years before the event of R & D along with the whole data set are given below:

Table 3. Regression Coefficients

	ALL DATA				OUTLIERS EXCLUDED			
	DISCRIMINANT		LOGIT		DISCRIMINANT		LOGIT	
	Predicted Sign	Coefficients	Predicted Sign	Coefficients	Predicted Sign	Coefficients	Predicted Sign	Coefficients
Panel A:One Year Before								
NITA	-	0. 028	-	3.376(0.232)	+	0.172	-	6.082(0.840)
CASCL	-	0.088	-	3.541(0.240)	-	0.184	-	10.044(0.244)
CASTA	+	0.370	+	10.258(0.131)	+	0.737	+	29.954(0. 196)
QATA	-	0.175	+	0.019(0.994)	+	0.077	-	5.102(0.475)
CASA	-	0.003	+	0.048(0.835)	-	0.036	-	1.871(0.484)
NWTD	-	0.009	-	0.249(0.682)	-	0.051	-	1.140(0.437)
RECINV	-	0.019	-	0.010(0.618)	-	0.087	-	0.296(0.712)
WCTA	+	0.101	+	0.375(0.872)	-	0.181	+	6.133(0.356)
TDTA	+	0.010	-	3.009(0.224)	-	0.242	-	9.368(0.221)
NISA	-	0.027	+	0.104(0.896)	-	0.019	+	4.221(0.681)
SAWC	+	0.006	+	0.001(0.845)	-	0.015	-	0.001(0.996)
Logassets	+	0.101	+	0.959(0.110)	-	0.096	-	1.161(0.505)
Industry	+	1.013	+	14.562(0.820)	+	1.056	+	18.122(0.704)
Eigenvalue=1.883								
	Correlation=0.808		X2=99.013		Correlation=0.847		X2=18.047	
	Wilk's Lamda=0.347		Significance=0.000		Wilk’s lamda=0.283		Signif.=0.114	
	X2=238.767		Wald test=99.934		X2=166.160		Wald test=61.476	
	Significance=0.000				Significance=0.000			
	Number of observations 722				Number of observations 699			
	Valid 234				Valid 140			
Panel B:Two Years Before(one and two)								
	ALL DATA				OUTLIERS EXCLUDED			
	DISCRIMINANT		LOGIT		DISCRIMINANT		LOGIT	
	Predicted Sign	Coefficients	Predicted Sign	Coefficients	Predicted Sign	Coefficients	Predicted Sign	Coefficients
NITA	-	0.052	-	2.235(0.173)	+	0.105	+	3.385(0.438)
CASCL	-	0.108	-	0.439(0.442)	-	0.070	-	0.044(0.943)
CASTA	+	0.279	+	4.049(0.075)	+	0.405	+	2.554(0.318)
QATA	+	0.075	+	1.204(0.393)	+	0.082	+	1.746(0.496)
CASA	+	0.297	+	0.030(0.743)	+	0.037	+	0.134(0.637)
NWTD	+	0.035	+	0.057(0.668)	+	0.079	+	0.179(0.548)
RECINV	-	0.024	-	0.006(0.599)	-	0.088	-	0.370(0.261)
WCTA	-	0.018	-	0.550(0.678)	-	0.126	-	1.558(0.457)
TDTA	-	0.151	-	1.480(0.136)	-	0.099	-	1.157(0.472)
NISA	+	0.003	-	0.037(0.915)	-	0.033	-	0.385(0.716)
SAWC	+	0.003	+	0.001(0.888)	+	0.008	+	0.080(0.531)
Logassets	+	0.165	+	1.126(0.004)	+	0.125	+	0.933(0.095)
Industry	+	1.023	+	15.531(0.708)	+	1.030	+	15.222(0.658)
	Eigenvalue=1.872							
	Correlation=0.807		X2=198.357		Correlation=0.832		X2=120.259	
	Wilk's Lamda=0.348		Significance=0.000		Wilk’s lamda=0.308		Signif.=0.000	
	X2=490.053		Wald test=201.646		X2=336.515		Wald test=128.397	
	Significance=0.000				Significance=0.000			
	Number of observations 1001				Number of observations 1001			
	Valid 473				Valid 294			
(p-values are given in parenthesis)								

Once the values of the discriminant coefficients are estimated, it is possible to calculate discriminant scores for each observation in the sample, or any firm, and to assign the observations to one of the groups based on this score. The essence of the procedure is to compare the profile of an individual firm with that of the alternative groupings. In this manner, the firm is assigned to the group it is most closely resembles.

All variables contribute marginally to the discrimination process when discriminant analysis is used. In case of logit NITA(Net Income/Total Assets) and CASTA(Cash/Total Assets) contribute to the discrimination process when two years data is used but more variables contribute to the discrimination process when one year data is used(NITA(Net Income/ Total Assets),CASCL (Cash/Current Liabilities),CASTA(Cash/Total Assets), WCTA (Working Capital/Total Assets),TDTA(Total Debt/Total Assets) and NISA(Net Income/Sales)) in particular when outliers are excluded.

H_2 indicates that making of R & D investments is rather negatively associated with profitability. H_3 indicates that Debt ratio (leverage ratio) is negatively associated with R & D.As far as leverage H_4 indicates that equity to debt ratio is negatively associated with R & D.Finally, H_5 indicates that the model is moderately discriminating.

As far as the correct classification, results offered in next Table 4 justify the preference of logit against discriminant analysis. Companies are more correctly classified using logit.

Table 4. Classification Table for GROUP (Percent Correct-Overall Index)

	Discriminant Analysis		Logit	
One-Year-Before(All data)	208(100.0)	0(0.0)	208	0(100.0)
	8(30.8)	18(69.2)	8	18(69.2)
	96.6%		96.6%	
One-Year-Before(Outliers excluded)	128(100.0)	0(0.0)	128	0(100.0)
	3(25.0)	9(75.0)	3	9(75.0)
	97.9%		97.9%	
Two Years-Before(All data)	420(100.0)	58(13.8	420	0(100.0)
	17(32.1)	38(67.9)	17	36(87.9)
	96.4%		96.4%	
Two Years-Before(Outliers excluded)	266(75.2	0(24.8)	266	0(100.00)
	8(28.6)	20(71.4)	8	20(71.4)
	97.3%		97.3%	

As far as classification accuracy, H_6 indicates that prediction accuracy is high and making of R & D investments can be forecasted.

It is worth noting that when assets size is included in the models the picture does not change when discriminant analysis is employed. When data for two years before the selection of auditors is employed the rate of correct classification increases from 78.4% to 78.6% (from 71.8% to 74.1% with outliers excluded).When data for one year before the R & D is used the rate increases from 71.9% to 73.2% (and remains the same when outliers are excluded). As

far as logit is concerned, using assets as a test variable with one year data the correct classification remains the same (89.4%) and also the same(93.0%) when outliers are excluded).When two years data are used the rate remains the same(89.2%) and decreases from 90.8% to 90.5% with outliers excluded.This is an evidence that size does not play a role in the prediction accuracy by the two models used.

These findings are very close to other business paradigms (i.e. bankruptcies, mergers and acquisitions, auditors' switching, etc.). Based on the above empirical findings, it is suggested that the prediction model is an accurate forecast of the event of R & D investments. Finally, normality in data sets played a role in the success of one versus the other model since the degree of normality led to logit rather than discriminant analysis.

5. Conclusions and Suggestions for Future Research

In an application of two dichotomous models that tested both the determinants of a dichotomous choice in an infantly investigated area of research in a specific country and worldwide the robustness of two widely used models indicates that the business event of R & D can be predicted by a rate higher than 90.0% using a logit specification. Variables selected in this study are good predictors while size does not play a role at all.

All variables contribute marginally to the discrimination process when discriminant analysis is used. In case of logit a number of variables contribute to the discrimination process (NITA (Net Income/ Total Assets), CASCL (Cash/Current Liabilities), CASTA (Cash/Total Assets), WCTA (Working Capital/Total Assets), TDTA (Total Debt/Total Assets) and NISA (Net Income/Sales) in particular when outliers are excluded.

This application has taken place in listed companies. How the situation would be formed in case of no listed companies is a matter for future research since the business environment would be different. Another venue for research is to investigate whether R & D spending has been changed since the adoption of IFRS provided that the accounting treatment has been differentiated.

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Note

Note 1. Myopic investment behavior (or "managerial myopia") refers to underinvestment in long-term, intangible projects such as R & D, advertising, and employee training for the purposes of meeting short-term goals.

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