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Impact of R&D Expenses on Firm Performance: Empirical Evidence from the BIST Information Technology Index

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Abstract: The relationship between R&D expenses and firm performance has been discussed and carefully studied for many years. Vast amount of research have been carried to figure out whether this relationship exist or not. Some researchers suggest that there is no relationship between R&D expenses and firm performance, others put forward the existence of negative or positive relationship. It can be asserted that possible existence as an useful information can be consumed by managers to increase the market value of firms. In that respect, the main aim of this research is to reveal the relationship between R&D and firm performance by taking into account 10 companies that are listed on the BIST Information Index for 5 years periods (between 2009 and 2013). In order to accomplish this purpose, we employed pooled regression model and cross sectional time series analysis technique. In general, although negative and positive coefficients are found, almost, all of them is not statistically significant. In other words, according to outcomes, it can be claimed that there is no relationship between R&D and firm performance which is line with previous studies.

Keywords: R&D Expenses, Firm Performance, BIST Inf. Tech. Index

JEL classification: G30, G32

1. Introduction

The growth of technological firms is based on innovative products and services, led them to invest in research and development (R&D) [Lantza & Sahutb, 2005]. It is significant to note that the relationship between R&D expenditures and firm's performance is vital for firm's managers whose aim is to maximise the present values of stockholders' value [Tubbs, 2007].

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In that context, The relationship between R&D expenditures and firm performance has been discussed and carefully studied for many years. Vast amount of research have been carried to figure out whether this relationship exist or not. Some researchers advocate that there is no relationship between R&D expenditures and firm performance, others suggest the existence of negative or positive relationship. It can be claimed that possible existence as an information can be employed by managers to increase the market value of firms. In that respect, the main aim of this research is to reveal the relationship between R&D expenditures and firm performance of 10 companies that are listed on the BIST Information Index for 5 years periods (between 2009 and 2013). In order to accomplish this purpose, pooled OLS test and cross sectional time series analysis technique were employed.

2. Literature Review

Many empirical researches have been carried to provide evidence that shows the correlation between R&D expenditures and firm performance. Many researchers have been interested in the correlation between R&D expenditures and the firm performance that is the indicator of firms' market value, and positive and significant relationship has been shown. Some of them are; Liang and Zhang (2005) figured out the relationship with 72 hi-tech companies as the sample. Connolly & Hirschey (1984) focused on 390 firms Fortune 500, and found the existence of a positive and significant relationship between the R&D expenditures and the firm's value. Similiarly, Hongwei & Cheng (2006) analysed the sample to 96 companies and figured out the positive impact of R&D investments on firms' market value.

Additionally, Bae & Kim (2003) examined this relationship for three leading economies- the USA, Germany, and Japan- , and found that R&D investment consistently has a significant positive effect on firms' value. Zhong & Zhou (2012) do the same work with a stochastic frontier model, and obtained the same conclusion with data of China market. According to market performance indicator perspective, Tobin's q, Hall et al. (2007) found positive and significant association as well. Also, Koellinger (2008), evaluated e-commerce companies in Europe. In his research, he found that companies engaged in internet-based innovations illustrate gerater performance than firms which do not invest in R&D. Vaccaro et al (2010) detemined the effective use of information management tools to develop new products and services, positeve affect on companies' performance.

3. Data, Variables and Methodology

3.1. Data

The book and market information of the 10 companies that are listed on the BIST Information Index for 5 years periods (between 2009 and 2013) is used for analysis. In order to obtain the data set, (http://www.imkb.gov.tr) and (http://www.kap.gov.tr), and websites of firms were examined in detail.

3.2. Dependent, Independent and Control Variables

Table 1 demonstrates the dependent, independent and control variables taken into account for our research. Notably, dependent variabes shown below were selected as performance indicators.

Table 1 : Dependent, Independent and Control Variables

Bağımlı Değişkenler (Tobins's q, ROA, ROE)		
Tabins'q	(Total Liabilities - Equity + Market Value) / Total Assets	Tobins'q
Return on Assests	Net Profit/ Total Assets	ROA
Return on Equity	Net Profit/ Equity	ROE
Bağımsız Değişkenler (OY1, OY2, OY3, H0)		
Change in R&D Expenditures	The Change in Annual Marketing Expenses	RD
Square of Change in R&D Expenditure	The Square of The Change in Annual Marketing Expenses	RD^2
BIST 100 Index Return	$Rt = \log(Pt/(Pt-1))$	R(BIST)
Kontrol Değişkenleri (Ln(S), K)		
Size of Sales	Natural Logarithm of Net Sales	Ln(s)
Leverage Ratio	Total Debt / Total Assets	LE

3.3. Model

Pooled OLS Test and cross sectional time series analysis technique were employed in order to figure out the realtionship between R&D expenses and firm performace. In this context, the regression models used for our investigation can be seen below;

$$ROA_{it}= \alpha_{it}+ \beta_1 RD_{it}+ \beta_2 RD^2_{it}+ \beta_3 R(BIST)_{it}+ \beta_4 Ln(s)_{it}+ \beta_5 LE_{it}+\varepsilon_{it} \qquad (1)$$

$$ROE_{it}= \alpha_{it}+ \beta_1 RD_{it}+ \beta_2 RD^2_{it}+ \beta_3 R(BIST)_{it}+ \beta_4 Ln(s)_{it}+ \beta_5 LE_{it}+\varepsilon_i \qquad (2)$$

$$Tobins'q_{it}= \alpha_{it}+ \beta_1 RD_{it}+ \beta_2 RD^2_{it}+ \beta_3 R(BIST)_{it}+ \beta_4 Ln(s)_{it}+ \beta_5 LE_{it}+\varepsilon_{it} \qquad (3)$$

Shown in Equation Tobin's'q, ROA and ROE performance criterias, and dependent variables; RD, RD^2 and R(BIST). Also, Ln (S) and LE demonstrates control variables. In addition, 'i' refers business 't' periods and 'N' represents the total number of enterprises.

4. Analysis

First of all, the effect of R&D expenditures on firm performance is detected by pooled OLS test. Afterwards, regarding Hausman test results, the fixed or random effects models are used. Under the fundamental assumption of OLS Test that is all companies used in research are same, the outcomes of thest are shown in Table 2. According to Table 2, regression results in three panels which are regression results generated by taking into account only one dependent variable ROA, ROE and Tobins' q in Model 1, Model 2 and Model 3 respectively. there are some positive and negative figures were found, even though none of them is statistically significant at any level of confidence selected. Furthermore, as Coşkun et al. (2010) suggested that any increase in marketing and R&D expenditures can affect company's performance in some positive way, although an expenditure level that above a certain level, this positive effect may change in a direction of opposite way. Parallel with the idea of them, the R&D expenditures squared analysis represents that even though it has possitive and negative impact on ROE and Tobins'q performance measurements, these effects been changed in opposite direction. It can be,thus, advocated that there is convcave relationship between firm performance and R&D expenditures. However, it should not be overlooked that this results are not significant.

Table 2: Pooled Regression Models' Outcomes

	Model -1- Dependent Variable: ROA			Model -2- Dependent Variable: ROE			Model -3- Dependent Variable: Tobin's q		
	Coeff.	T-stat	Sig.	Coeff	T-stat	Sig.	Coeff	T-stat	Sig.
C	-0,175	-0,781	0,439	-0,793	-2,121	0,040	-618,534	-2,756	0,009
RD	0,000	0,015	0,988	-0,030	-0,590	0,558	2,242	0,075	0,941
RD^2	0,001	0,168	0,868	0,006	1,044	0,302	-0,044	-0,012	0,991
R(BİST)	-0,014	-0,534	0,596	0,013	0,299	0,766	-31,990	-1,222	0,228
Ln(s)	-0,135	-1,607	0,115	-0,359	-2,569	0.013**	-44,429	-0,530	0,599
LE	0,015	1,070	0,291	0,055	2,389	0.021**	34,220	2,489	0.016**
R^2		0,427			0,190			0,227	
Adj. R^2		0,392			0,098			0,139	
Observ.		50			50			50	

Note: , *** , ** and * demonstrate statistically significance at level 1%, 5% and %10 respectively.

According to pooled OLS test, all companies are the same as used in the analysis is fundamentally assumed, it is not possible to accept that this assumption is exist in market conditions. Hence, Hausman Test is used in order to determine fixed or random effects model for analysis of relationship of R&D expenditure and firm performance which shown in Table 3. According to the Hausman test outcomes, it is found that fixed effect model is more active than random effect model for all model applied. Therefore, fixed effect model is used for evaluation for all models based on the Hausman test outcomes.

Table 3: Statistical Testing of Regression Models

	Model-1	Model-2	Model-3
Hausman Test	0,756	0,571	2,403
P-Value	0,980	0,989	0,791

Note: , *** , ** and * demonstrate statistically significance at level 1%, 5% and %10 respectively.

Table 4 illustrates fixed effects' and random effects' model estimation results depending on Hausman Test. As mentioned above, examination of the fixed effects methods, which taken into account for all, demonstrates smiliar figures which were obtained fromd running Pooled OLS Test. Therefore it can be said that there is no proof which shows statistically significant realtionship between R&D expenditures and firm performance in the context of Turkish firms that are listed on the BIST Information Index.

Table 5 indicates the R&D Expenditures, GDP and Scientists and Engineers per Million People indicators for selected countries throughout the world. The the far right refers a country which devotes largest share of GDP for R & D expenditure. Also, the top of the chart represents a country that has relatively the highest number of scientists and engineers in its population. Eventually, the size of circle reflects the relative amount of annual R&D spending by indicated country. Having done the interpretation of the chart above, it can be seen that Turkey is on the left bottom side of the chart that means it has informationally lagged behind many countries. This stiation can negatively effect the main idea of our research which advocate the positive significant correlation. As shown in the analysis part of the research, the correlation between R&D expenditures and firms performance has not been revealed. The reason of this circumstance can be altered by employing diferent market data. In other words, whole direction of the country towards the R&D investments has a vital role that influce all sectors in country' economic system.

Table 4: Fixed Effects' and Random Effects' Model Estimation Results

	Model -1- Dependent Variable: ROA			Model -2- Dependent Variable: ROE			Model -3- Dependent Variable: Tobin's q		
	Coeff.	T-stat	Sig.	Coeff	T-stat	Sig.	Coeff	T-stat	Sig.
C	-0,927	-1,029	0,311	-1,438	-1,039	0,306	-689,277	-0,793	0,433
RD	0,003	0,097	0,923	-0,026	-0,494	0,624	-4,075	-0,122	0,904
RD^2	0,000	0,064	0,949	0,006	0,874	0,388	0,402	0,097	0,924
R(BİST)	-0,016	-0,567	0,574	0,012	0,277	0,783	-31,053	-1,129	0,267
Ln(s)	-0,233	-0,839	0,407	-0,634	-1,491	0,145	-208,503	-0,780	0,440
LE	0,058	1,108	0,275	0,097	1,206	0,236	42,407	0,840	0,406
R^2	0,632			0,357			0,328		
Adj. R^2	0,511			0,100			0,059		
Observ.	50			50			50		

Note: , *** , ** and * demonstrate statistically significance at level 1%, 5% and %10 respectively.

Table 5: R&D Expenditures, GDP and Scientists and Engineers per Million People
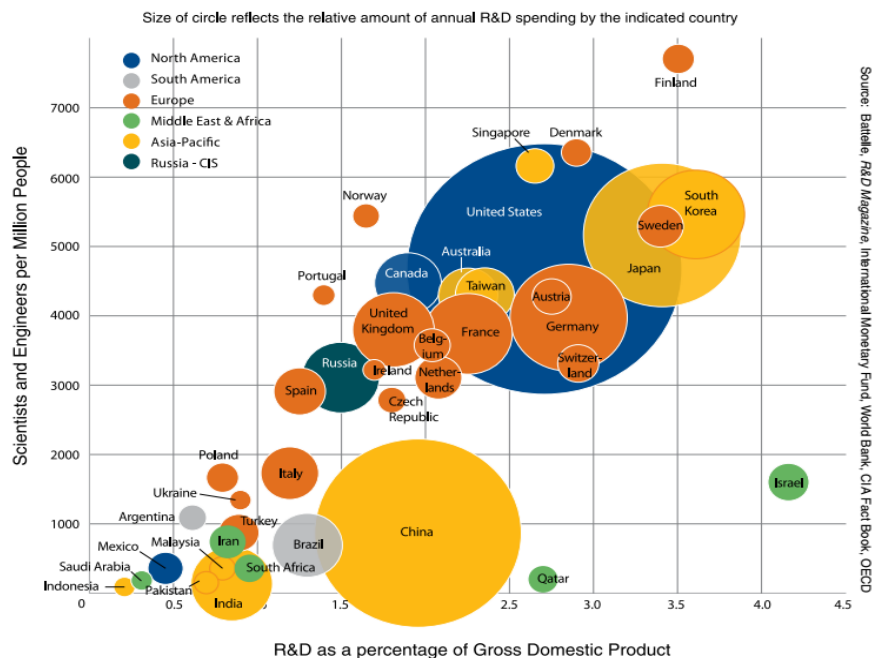
Source: Battelle, R&D Magazine, International Monetary Fund, Worlbank, CIA Fact Book, OECD

Conclusion

This research investigated the relationship between the relationship between R&D expenditures and firm performance of 10 companies that are listed on the BIST Information Index for 5 years periods from 2009 to 2013. In order to this aim, pooled OLS test and cross sectional time series analysis technique and pooled OLS method were employed. According to pooled OLS results for Model 1, Model 2 and Model 3, there are some positive and negative figures were figured out, although none of them is statistically significant at any level of confidence selected for both RD and RD^2. Notably, It can be, advocated that there is concave relationship between firm performance and R&D expenditures. Yet, these results are not significant. Analysis of relationship by using cross sectional time series indicates that examination of the Fixed effects methods, which taken into account for all model employed, demonstrates similar figures which were obtained from running Pooled OLS Test. Hence, it can be said that significant relationship between

R&D expenditures and firm performance is not proved for firms that are listed on the BIST Information Index. Moreover, we realized that the Turkey's place in the rankings of the R&D Expenditures, GDP and Scientists and Engineers per Million People indicators is behind many countries which might be the reason why R&D expenditure level is not a variable that affect company's market value or performance.

Taking all into the consideration, it can be claimed that in line with the literature the relationship between marketing expenditure and firm performance exists. It should also be, however, highlighted that possible data or market change may reduce or strengthen the reliability of the findings obtained.

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