Impact of R&D Expenses on Firm Performance: Emprical Evidence From the BIST Information Technology Index[*]

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The relationship between R&D expenses and firm performance has been discussed and carefully studied for many years. Vast amount of researches have been carried out to figure out whether this relationship exists 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 a 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 five years period (between 2009 and 2013). In order to accomplish this purpose, pooled regression model and cross sectional time series analysis technique are employed. In general, although negative and positive coefficients are found, almost, all of them are 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 Information Technology Index

Introduction

The growth of technological firms is based on innovative products and services, which 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 performance is vital for firm's managers whose aim is to maximise the present values of stockholders' value (Tubbs, 2007).

In this context, the relationship between R&D expenditures and firm performance has been discussed and carefully studied for many years. Vast amount of researches have been carried out to figure out whether this relationship exists 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 realtionship. It can be claimed that possible existence as an informaion 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 five years period (between 2009 and 2013). In order to accomplish this purpose, Pooled OLS Test and cross sectional time series analysis technique were employed.

Literature Review

Many empirical researches have been carried out to provide an 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), they figured out the relationship with 72 hi-tech companies as the sample. Connolly and Hirschey (1984) focused on 390 firms of Fortune 500, and found the existence of a positive and significant relationship between the R&D expenditures and the firm's value. Similiarly, Hongwei and Cheng (2006) analysed the sample of 96 companies and figured out the positive impact of R&D investments on firms' market value.

Additionally, Bae and 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 and Zhou (2012) did 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, Thoma, and Torrisi (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, Parente, and Veloso (2010) detemined the effective use of information management tools to develop new products and services that positively affect companies' performance.

Data, Variables, and Methodology

Data

The book and market information of the 10 companies that are listed on the BIST Information Index for five years period (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.

Dependent, Independent, and Control Variables

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

Table 1

Dependent, Independent and Control Variables

Bağimli değişkenler (Tobin's *q*, *ROA*, *ROE*)		
Tobins'*q*	(Total liabilities – Equity + Market value)/Total assets	Tobin's *q*
Return on assests	Net profit/Total assets	*ROA*
Return on equity	Net profit/Equity	*ROE*
Bağimsiz değişkenler (OY1, OY2, OY3, H0)		
Change in R&D expenditures	The ehange in annual marketing expenses	*RD*
Square of ehange in R&D expenditure	The equare of the change in annual marketing expenses	*RD^2*
BIST 100 index return	$Rt = \log (Pt/(Pt\text{-}1))$	*R*(BIST)
Kontrol değişkenleri (Ln(*s*), K)		
Size of sales	Natural logarithm of net sales	Ln(*s*)
Leverage ratio	Total debt/Total assets	*LE*

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 the investigation can be seen below:

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

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

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

Shown in Equation Tobin's q, ROA, and ROE performance criterias, and dependent variables; RD, RD^2, and $R(\text{BIST})$. Also, $\text{Ln}(s)$, and LE demonstrate control variables. In addition, "i" refers business, "t" period and "N" represents the total number of enterprises.

Analysis

First of all, the effect of R&D expenditures on firm performance is detected by Pooled OLS Test. Afterwards, regarding Hausman Test's 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 these 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 Tobin's q in Model 1, Model 2, and Model 3 respectively. Some positive and negative figures were found, even though none of them is statistically significant at any level of confidence selected. Furthermore, as Coşkun, Kök, and Yücel (2010) suggested that any increase in marketing and R&D expenditures can affect company's performance in some positive ways. In additon, if the expenditure level which is above 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 Tobin's q performance measurements, these effects have 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 these 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(BIST)	-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	

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

According to Pooled OLS Test, that all companies used in the analysis are the same is fundamentally assumed, it is not possible to accept this assumption, which exists in market conditions. Hence, Hausman Test

is used in order to determine fixed or random effects model for analysis of relationship between R&D expenditure and firm performance, which is shown in Table 3. According to the Hausman Test's outcomes, it can be found that fixed effect model is more active than random effect model for all models applied. Therefore, fixed effect model is used for evaluation for all models based on the Hausman Test's 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

Notes. ***, **, 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 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(BIST)	-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	

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

Figure 1 indicates the R&D expenditures, GDP, and scientists and engineers per million people indicators for selected countries throughout the world. It also refers a country which devotes the largest share of GDP for R&D expenditure. Also, the top of Figure 1 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 Figure 1, it can be seen that Turkey is on the left bottom side of Figure 1 that means it has informationally lagged behind many countries. This situation can negatively affect the main idea of the research which advocates 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 influences all sectors in country's economic system.
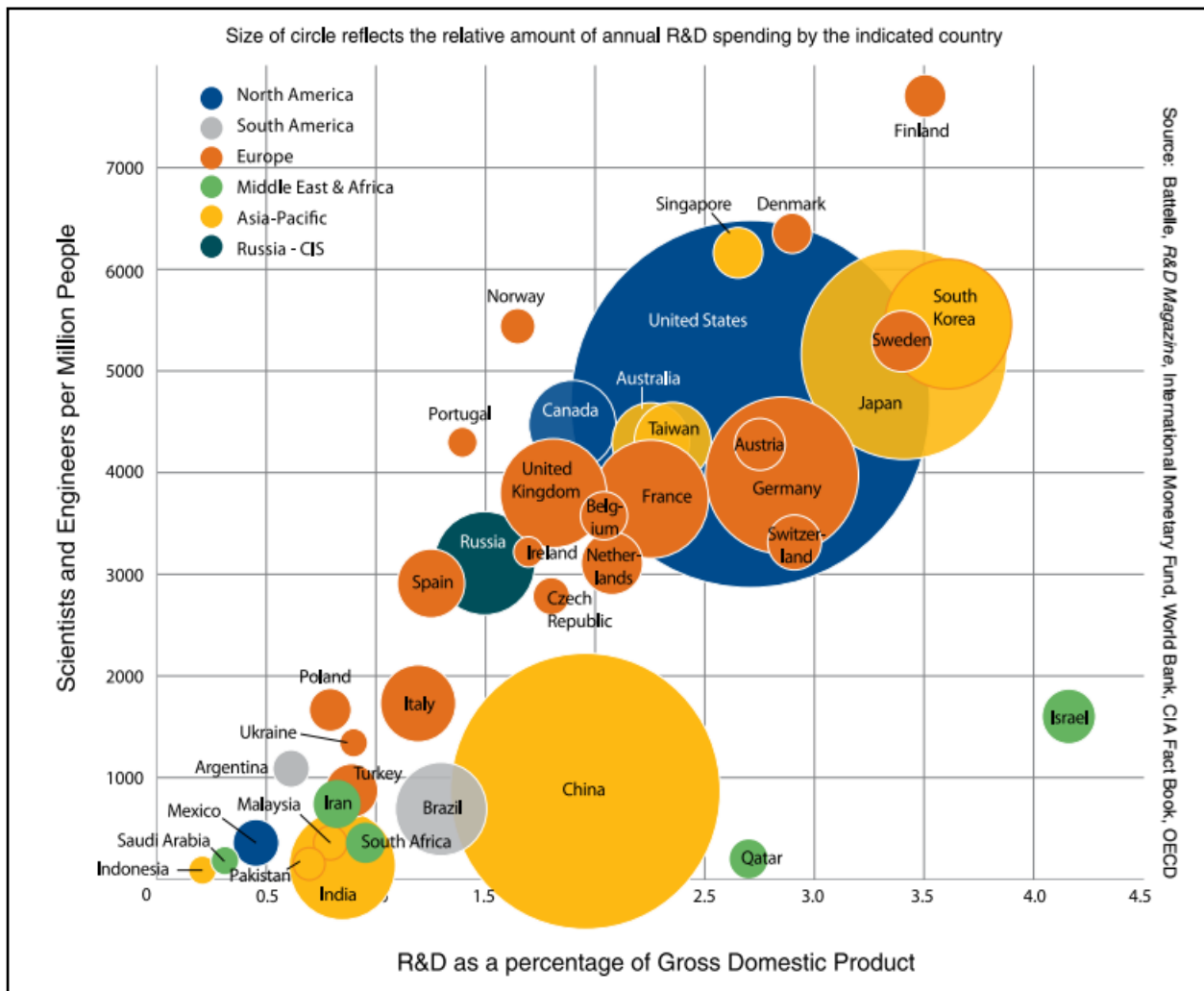
Figure 1. R&D expenditures, GDP, and scientists and engineers per million people. Source: Battelle, R&D Magazine, International Monetary Fund, Worlbank, CIA Fact Book, OECD.

Conclusion

This research investigated the relationship between R&D expenditures and firm performance of 10 companies that are listed on the BIST Information Index for five years period from 2009 to 2013. In order to achieve 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 a convcave 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 took into account for all models employed, demonstrates smiliar figures which were obtained from running Pooled OLS Test. Hence, it can be said that significant realtionship between R&D expenditures and firm performance is not proved for firms that are listed on the BIST Information Index. Moreover, it is realized that 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 varibale that affects 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.

References

Bae, S. C., & Kim, D. (2003). The effect of R&D investment on market value of firms: Evidence from the US, Germany and Japan. *Multinational Business Review, 11*(3), 51-75.

Connolly, R. A., & Hirschey, M. (1984). R&D, market struc-ture and profits: A value-based approach. *Review of Economics and Statistics, 66*(4), 682-686.

Coşkun, E., Kök, D., & Yücel, A. (2010). Pazarlama faaliyetlerinin firma değerine kisa ve uzun dönem etkilerinin ıncelenmesi. *Finans Politik ve Ekonomik Yorumlar, 47*(540), 67-76.

Hall, B. H., Thoma, G., & Torrisi, S. (2007). The market value of patents and R&D: Evidence from european firms. *NBER Working Paper*. Cambridge.

Hongwei, C., & Changi, Y. (2006). An empirical study on the relationship between R&D ınputs and performance. *Scientific Management Research, 3,* 110-113.

Koellinger, P. (2008). The relationship between technology, innovation and firm performance-empirical evidence from e-business in Europe. *Research Policy, 37,* 1317-1328.

Lantza, J., & Sahutb, J. (2005). R&D investment and the finan-cial performance of technological firms. *International Journal of Business, 10*(3), 251-269.

Liang, L., & Zhang, H. (2005). An empirical study on the R&D inputs performance of high-tech enterprises. *J. Cent. South University,* 232-236.

Tubbs, M. (2007). The relationship between R&D and company performance. *Research-Technology Management, 50*(6), 23-30.

Vaccaro, A., Parente, R., & Veloso, F. M. (2010). Knowledge management tools, inter-organizational relationships, innovation and firm performance. *Technological Forecasting and Social Change, 77,* 1076-1089.

Zhong, L., & Zhou, Q. (2012). R&D investment, R&D efficiency and enterprise performance under the restriction of endogenous the sample of high-tech segment industries of China. *Soft Science,* 11-14.