➔ *Regular Research Paper – SS*

Analysis of the Relationship between R & D Expenditure and Profitability: A Sample Application from BIST

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Abstract

Gaining competitive advantage of countries and firms largely depends on innovation and developing new products. R & D activities provide important contribution to growth and also performance of firms. The pharmaceutical sector is a strategic sector as well as its added value is high. Moreover, this sector necessitates high R & D expenditures. In this study, a sample application will be given after emphasizing to the global developments in the R & D and pharmaceutical sector. In this context, the causality relationship between R & D expenditures, gross profit and operation profit variables of one of the largest pharmaceutical firm in Turkey is investigated based on quarterly time series for the period of 2005:1-2015:3. The relationships between variables are tested by Granger Causality Test. According to the findings, it is found that there is a one-way causality relationship from R & D expenditures towards operational profit.

Keywords: *r & d expenditures, profitability, pharmaceutical sector, granger causality test*

1. INTRODUCTION

R & D is an important functional area of management discipline. Gaining the competitive advantage of countries and businesses at the same time depends on large-scale innovation and the development of new products. R & D activities provide significant contributions to the growth and performance of businesses. Effective management of R & D activities in today's business life where competitive advantages are sought is not only critical but also part of the survival strategy. The ability of businesses to achieve strategic gains in a rapidly changing and evolving business environment depends on implementing innovative business processes. Businesses must be able to cope with their competitors both in the domestic and foreign competitive environment, and to include in their innovative strengthening structures in order to increase their sales and profitability. Otherwise, they will lose market share in the face of competitors, decrease their profitability and perhaps end their activities. R & D, the process embodied by innovative ideas in this framework, is an application process consisting of

systematic works, in which ideas are transformed into knowledge, knowledge is transformed into products, new and untested characteristics are obtained, and engineering-oriented applications are involved. Essential functions of R & D studies are to create or discover new information about scientific and technological issues and to develop new products in order to enable and reveal the development of new and valuable products, services and processes.

One of the sectors with the highest added value in the world is the pharmaceutical sector. The demand for the pharmaceutical sector worldwide is rapidly increasing in the context of population growth, life span, urbanization and environmental problems. R & D work in the pharmaceutical sector is the process of discovering, developing and acquiring new drugs that are sold to the market by prescription. R & D studies in this sector involve many different scientific and clinical activities.

One of the potential consequences of R & D expenditures made at the enterprise level is the positive effect on the firm profitability. Indeed, Ambrammal and Sharma (2016), Chen et al. (2016), Warusawitharana (2015), Voulgaris and Lemonakis (2014) have found findings in this area. This study, which is designed to investigate the relationship between R & D expenditures and profitability, consists of five parts. After the introductory section, the second section emphasizes R & D investments at global level and the latest developments in the pharmaceutical sector. The fourth section is the part where methodological examination is made and the relation between R & D expenditures and business profitability is examined by Granger Causality Test. At the final, the last section gives the results of the study and focuses on suggestions.

2. R & D ACTIVITIES AND GLOBAL DEVELOPMENTS IN DRUG SECTOR

The world economy has undergone significant transformation in especially last 30 years. In the process of transition from the industrial society to the information society, rapidly developing and constantly changing technology is inevitably pushing for structural transformations. Labor-intensive manufacturing activities in industrialized countries are shifting to developing countries where labor is cheaper and easier to reach; instead, technology-based, value-added, knowledge-intensive and innovative production model dominates the whole economy. At this point, R & D activities and innovativeness are distinguished and distinguished (Gergerli, 2015:11). R & D expenditures are not only in terms of business but also in terms of national economies. Some of these acquisitions are reducing the country's current account deficits, reducing external dependency in sectors with strategic priorities, and being one of the dynamics of economic growth. The ability to achieve sustainable competitive advantage globally in this framework depends on new and technological products / processes that will emerge as a result of R & D activities. In Table 1 below, the ratios of R & D expenditures to GNP of some countries are shown for years.

Table 1. Ratio of R & D expenditures to GNP (%).

Countries/Years	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EU (28 countries)	1,8	1,76	1,76	1,78	1,78	1,85	1,94	1,93	1,97	2,01	2,03	2,03
Finland	3,3	3,31	3,33	3,34	3,35	3,55	3,75	3,73	3,64	3,42	3,3	3,17
France	2,11	2,09	2,04	2,05	2,02	2,06	2,21	2,18	2,19	2,23	2,24	2,26
Germany	2,46	2,42	2,42	2,46	2,45	2,6	2,72	2,71	2,79	2,87	2,83	2,84
Italy	1,06	1,05	1,05	1,09	1,13	1,16	1,22	1,22	1,21	1,27	1,3	1,29
Japan	3,14	3,13	3,31	3,41	3,46	3,47	3,36	3,25	3,38	3,34	3,47	*
Norway	1,68	1,55	1,48	1,46	1,56	1,56	1,72	1,65	1,63	1,62	1,65	1,71

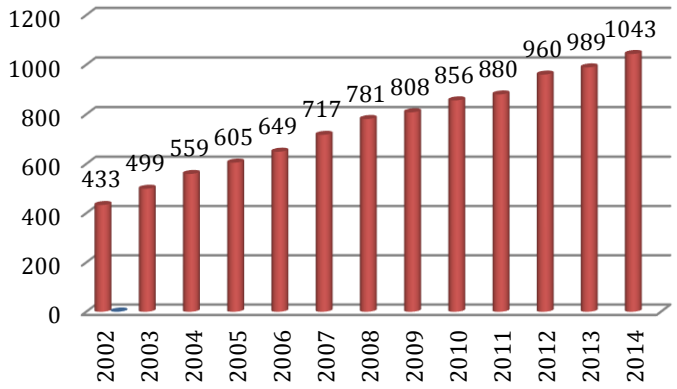
Russia	1,29	1,15	1,07	1,07	1,12	1,04	1,25	1,13	1,09	1,13	1,13	1,19
South Korea	2,35	2,53	2,63	2,83	3	3,12	3,29	3,47	3,74	4,03	4,15	*
Sweden	3,61	3,39	3,39	3,5	3,26	3,5	3,45	3,22	3,25	3,28	3,3	3,16
Turkey	0,48	0,52	0,59	0,58	0,72	0,73	0,85	0,84	0,86	0,92	0,95	1,01
United Kingdom	1,67	1,61	1,63	1,65	1,69	1,69	1,75	1,69	1,69	1,63	1,69	1,72
United States	2,55	2,49	2,51	2,55	2,63	2,77	2,82	2,74	2,77	2,81	*	*
China (except Hong Kong)	1,13	1,23	1,32	1,39	1,40	1,47	1,70	1,76	1,84	1,98	2,01	*

Source: Compiled from OECD and official Web pages of Eurostat.
* The data could not be obtained.

As shown in Table 1, the share of R & D spending in the GNP is almost 2% or more in almost all of the developed economies of the world and at the same time the technical brand countries, and this ratio is increasing over the years.

The European Commission (2015) published "EU 2015 Industrial R & D Investments" and in this report, they listed the industry sector ranking in terms of R & D intensity in the world (by 2015). The ranking is as follows: 1- Pharmaceuticals & Biotechnology (14.4%) 2- Software & Computer (10.1%) 3- Technology Hardware & Equipment (8%) 4- Entertainment Products (5.8%) 5- Space and Defense (4.5%). As it can be seen from this ranking list, the sector with the highest R & D intensity has been the pharmaceutical and biotechnology sector.

The prolongation of life span throughout the world, the increase in access to quality of life and access to health services, and the emergence of a protective state mentality have played an important role in the growth of the world pharmaceutical industry. Indeed, according to Thomson Reuters (2015), the world pharmaceuticals sector grew by 5.5% in 2014, reaching a market volume of 1 trillion US dollars. In the Figure 1 below, World Drug Sector sales figures are shown for years.



Source: http://cmr.thomsonreuters.com/pdf/Executive_Summary_Final.pdf

Figure 1. World pharmaceutical sector sales numbers (in billion US $).

As it can be seen from Figure 1, worldwide pharmaceutical sales have increased steadily over the last 13 years. The growth rate of the world pharmaceutical industry in the 2002-2014 period was 140%. These states indicate that the demand for the pharmaceutical sector in the world has increased more in each year. In the Table 2 below, R & D expenditures in the pharmaceutical sector have been shown over the years.

Table 2. R & D expenditures in the world drug sector (in billion US $).

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2016*	2017*	2018*	2019*	2020*
108	120	129	128	129	136	135	137	142	141	144	147	152	155	160

Source: http://www.statista.com/statistics/309466/global-r-and-d-expenditure-for-pharmaceuticals/
***** Predicted data

In line with the growth in the pharmaceutical sector, it is seen from the Table 2 that the R & D investments in the sector are also on an increasing trend. This situation can be interpreted as an increase in competition with the high demand in the sector leading to the development of new drugs and molecules.

3. THE ASSOCIATED LITERATURE

In the academic literature, there are many scientific studies examining the interaction between R & D investments and different business performance measures. Some of them are related to R & D investments and business profitability, and some are scientific studies focused on examining the effects of R & D investments on the business market value or sales. A review of the literature on the topic in this framework can be summarized as follows.

Coombs and Bierly (2006) examined the data of large scale 201 manufacturing operations in the US and tried to determine the relationship between technological capacity and business performance. Multiple regression analysis was used as an econometric method in the study. Accounting and market-based performance measures were used in the study. As a result of the analyzes made, the density of R & D; Negative value on market value and market value, positive effect on economic value added, while negative effect on sales profitability, equity profitability and asset profitability is determined.

Shin, et al. (2009) examined the effects of R & D expenditures on the performance of firms in their work towards global electronics industry within the context of multiple regression analysis. In this context, it is stated that R & D spending has a positive and statistically significant effect on gross profit in the result of the study conducted by 200 operators in 2000-2005 period, whereas the relation between R & D spending and equity return and asset profitability is not statistically significant.

Hajiheydari, et al. (2011) examined the effects of R & D investments on business profitability using a simple regression analysis using the 2010 data of the world's top 20 pharmaceutical companies. It is emphasized that R & D expenditures have a positive and statistically significant effect on operating sales and profitability.

In the study by Chumaidiyah (2012), technological capability of enterprises and effect of R & D capacity on profitability were examined with t-test and path analysis by taking the data of 84 operators in Telecommunication sector of Indonesia into consideration. As a result of the study, it is stated that R & D expenditures increase the profitability of sales, profitability of equity and asset profitability.

Rao et al. (2013) examined comparatively the impact of technology-intensive firms in China and Japan on the performance of R & D expenditures. Panel data methodology was used for the 2007-2011 period review. As a result of the study, it is stated that R & G expenditures have a negative effect on operating performance (equity profitability) in the current period, but a positive and meaningful effect has emerged in t + 2 for China and t + 1 years for Japan.

Ghaffar and Khan (2014) explored the effects of R & D investments on firm performance in the context of correlation and regression analysis, taking advantage of annual data for 2007-2012 period of 8 drug companies registered on the Pakistani stock exchange. As a result of the study, it is stated that R & D investments have a positive effect on business asset profitability, equity return and profitability per share.

Ayaydin and Karaaslan (2014) explored the effects of R & D expenditures on the financial performance of the enterprises by using quarterly data for 2008-2013 of 145 manufacturing industry registered in Turkey. As a result of the panel data methodology analysis, the R & D intensity, defined as the ratio of R & D expenditures to net sales, has a positive and significant effect on the business financial performance as defined by the asset profitability.

Vithessonthi and Racela (2015) studied the effects of R & D expenditures on business performance, taking into account the 1990-2013 period data for businesses outside the financial sector of the US Stock Exchanges. In the study in which the panel data econometrics were used, the asset-profitability and the profitability ratios of sales in the measurement of accounting-based activity performance; The share of stock return and Tobin's Q ratios were used as dependent variables in measuring market-based financial performance. R & D intensity is defined as the ratio of R & D expenditures to total assets one year before. As a result of this study, it has been stated that the R & D intensity has a negative effect on the operational performance of the firms, whereas it has a positive and statistically significant effect on the market value of the company defined by the stock return and the Q rate of Tobin.

Ozturk and Zeren (2015) examined the effect of R & D spending on the sales of 26 manufacturing industry operations in Turkey. Panel data econometrics were used in the study and quarterly data for 2007-2014 were taken into consideration. As a result, a positive and meaningful relationship was found on the growth related to business sales of R & D expenditures.

Another study that examines the relationship between R & D expenditures and business profitability was done by VanderPal (2015). In the study, 103 operators analyzed the data (of 1980-2013 period) in the context of panel data econometrics. As a result of the study, it was determined that there is a positive and meaningful relationship between R & D expenditures and net profit and return on equity, while there is a negative and significant relationship between R & D expenditures and operating profitability.

Nunes and Serrasqueiro (2015) have tried to determine the factors that influence the profitability of information-intensive businesses in Portugal in their work. The sample of the study was 187 firms between 2002-2009 and the dynamic panel data analysis econometrics were used. As a result of the study, R & D expenditures on the profitability of the business, which is defined as asset profitability, has a significant positive effect.

Xu and Jin (2016) have explored the effects of R & D investments on business performance in the context of multiple regression analysis by using the annual data for the 2011-2013 period of 30 enterprises in the internet and information sector registered in China. It is emphasized that while the R & D investment does not have a significant effect on the operating performance of the operator, it is emphasized that a lagged value of R & D investments has a positive and statistically significant effect on the operating performance.

The study by Jin et al. (2016) differs from other studies with the R & D intensity as a dependent variable. In the study, the 1958 company in China benefited from the 2007-2010 data. In the study using multiple regression analysis, a positive and statistically significant relationship was found between R & D intensity defined as the ratio of R & D expenditures to total assets and asset profitability. In other words, the high profitability of businesses provides strong financial support for Research-Development investments.

4. METHODOLOGY

4.1. Data

Research and development expenditures, gross profit and operating profit data related to 2005: 1-2015: 3 periods of a pharmaceutical company operating in Stock Exchange Istanbul have been utilized in the study to investigate the relationship between research development expenditures and profitability.

The abbreviations for the variables used in the study are as follows;

LNREDE: Research and development expenses,
LNBPRF: Gross profit
LNFPRF: Operating profit

The data are obtained from the electronic database of Stock Exchange Istanbul and the natural logarithms of the series are taken and are free from seasonal effects. The E-views 8 program was used in the analysis of the data.

4.2. Findings

In researching the relationship between research and development expenditures and firm profitability, we first looked at the stasis levels of the variables. In this phase, an extended Dickey Fuller (Augmented Dickey Fuller-ADF) unit root test was used to examine the stationary of the variables. The regression equation used in the ADF test developed by Dickey and Fuller (1981) can be written as follows for a fixed and trendy model.

$$\Delta y_t=\mu+\lambda y_{t-1}+\alpha_i \sum_{i=1}^{k} \Delta y_{t-i}+u_t \quad \text{(fixed term model)}$$

$$\Delta y_t=\mu+\beta T+\lambda y_{t-1}+\alpha_i \sum_{i=1}^{k} \Delta y_{t-i}+u_t \quad \text{(fixed term and trendy model)}$$

Δy_t = Differentiated series — λ, β, α_i = Parameters

μ = Fixed term — T = Trend factor

k = Delay length — u_t = Error term

In the study, the unit root test was performed with the extended Dickey-Fuller (ADF) test and the optimal delay length was determined according to the AIC information criteria when the number of delays was determined. First, the information criteria such as Akaike, Schwarz (SC), and Hannan-Quinn (HQ) were used in determining the optimal number of delays to be used in the VAR model to be estimated after the stationary properties of the variables were examined. Starting from the model which gives the lowest number of delays for a more accurate model (parsimonious) estimation, the delay length in which there is no consecutive dependency and variable variance in the error terms of the model is taken as the optimal length because these criteria are different from each other and the number of samples is low. In the study, Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) each gave the same number of delays. However, the AIC information criterion is preferred. The reason for this is that it is widely used in the literature besides giving the delay length which gives the model the smallest critical value.

Table 3. Improved Dickey Fuller (ADF) unit test results.

Variable	ADF Test
LNREDE	-3.730898 (9)
LNBPRF	-7.294070 (9)
LNFPRF	-7.164435 (9)

Note: It is at a level of significance of 0.01. The optimum lag length was calculated according to the information criterion of the Akakike Information criterion (AIC) and is shown in parentheses. Mc Kinnon critical values; -3.552666 at the level of 1%, -2.914517 at the level of 5%, -2.595033 at the level of 10%.

According to the ADF unit root test results, the null hypothesis that the unit root is found is rejected if the test statistic calculated in the R & D expenditure, gross profit and activity profit series fixed (cut) -trendsized model is absolutely larger than the MacKinnon critical value at the 1% significance level. In other words, it is seen that in the fixed (interrupted) -trendless model of the series, the level is stable and the degree of integration is I (0).

One of the analysis methods used to determine the causality relationship between variables is Vector (VAR) causality analysis. This application of causality analysis takes place in two stages. First, the maximum integration degree (d) and delay length (k) of the variables in the system are required. Measures such as Akaike's minimum Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC) and Hannan-Quin (HQ) can be used to determine the appropriate delay structure of VAR (Awokuse, 2003).

Among the variables required to construct a VAR model, it is seen that the integration level is I (0) and the stationary (interrupted) -trendless model is stationary at the level value. For this reason, there is no need for a test of con- version (Granger, 1988).

In this phase, the Granger (1988) causality test, which is a causal relation between research and development, gross profit and operating profit variables, has a static structure based on the least squares method (LSM) estimation of the following equations.

$$LNREDE = \propto_1 + \sum_{i=1}^{n} \beta_{1i}\, LNREDE_{t-i} + \sum_{i=1}^{n} \gamma_{1i}\, LNFPRF_{t-i} + u_{1t} \quad (1)$$

$$LNFPRF = \propto_1 + \sum_{i=1}^{n} \beta_{1i}\, LNFPRF_{t-i} + \sum_{i=1}^{n} \gamma_{1i}\, LNREDE_{t-i} + u_{1t} \quad (2)$$

$$LNBPRF = \propto_1 + \sum_{i=1}^{n} \beta_{1i}\, LNBPRF_{t-i} + \sum_{i=1}^{n} \gamma_{1i}\, LNREDE_{t-i} + u_{1t} \quad (3)$$

In the Granger Causality Test based on VAR, the AIC criterion was used to determine the optimal lag length. Optimal lag lengths are set to 1 for models with all variables.

Standard granger causality for *LNREDE*, *LNBPRF* and *LNFPRF* variables According to the test results (Table 4), it is assumed that the null hypothesis that there is no causality relation towards the *LNBPRF* and *LNFPRF* variables from the *LNREDE* variable is rejected. In other words, research and development expenditures have resulted in a lack of a causal relationship to gross profit and operating profit. However, there is a right causality relationship between research and development expenses.

Table 4. VAR Granger causality test results.

Test period :2005:1-2015:3		
Number of Delays: 9	**F test**	**Probability**
LNREDE does not Granger Cause *LNFPRF.*	10.5961	0,0005

LNFPRF does not Granger Cause *LNREDE.*	0.83078	0.5993
Number of Delays: 9		
LNREDE does not Granger Cause *LNBPRF.*	0.639103	0.4240
LNBPRF does not Granger Cause *LNREDE.*	0.26645	0.9747

In the Standard Granger Causality Test applied to research and development, gross profit and operating profit variables, the null hypothesis that research and development costs and causality relation between operating profit variables are absent is rejected. While there is no causality relationship between research and development costs and gross profit, there is a causal relationship between research and development expenses and operating profit. The null hypothesis that there is no causal relationship between research and development expenditure variables in the gross profit and operating profit variables in the study was accepted. It is seen that the change in research and development expenses affects the operating profit.

5. CONCLUSION

In this study, causality relation between R & D expenditure, and gross profit and operating profit variables was investigated by using 2005:1-2015:3 period quarterly time series. Relations between variables were analyzed using the Granger causality test. According to findings, there is a one-way causality relationship from research and development expenditures towards operating profit.

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