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Relationships Between R&D and Corporate Performance: An Empirical Analysis in Istanbul Stock Exchange

Ar-Ge Ve Firma Performansi Arasindaki İlişki: Borsa İstanbul Üzerine Ampirik Bir Analiz

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ABSTRACT

By making it possible to produce innovative products and services, Research and Development (R&D) investments provide long term growth and competitive advantages and create value for corporations. However, they require significant investment expenditures. The objective of the present study is to analyze the relationship between R&G investments and financial performances of corporations. For this purpose, 20 chemical companies traded in Bourse Istanbul are analyzed with a panel data method, Generalized Method of Moments (GMM). Study findings demonstrated that R&D expenses affected corporate financial performance positively and significantly with one year lag.

Keywords: *Research and Development, Firm Performance, Chemical Industry, Dynamic Panel Data Analysis, System GMM*

ÖZET

Ar-Ge yatırımları, inovatif ürün ve hizmetlerin üretilmesini mümkün kılarak, firmalara uzun dönemli büyüme ve rekabet avantajı sağlayan ve değer yaratan faaliyetlerdir. Ancak önemli tutarlarda yatırım harcamalarını da gerektirmektedir. Bu çalışmanın amacı, Ar-Ge yatırımları ile firmaların finansal performansı arasındaki ilişkinin analiz edilmesidir. Bu doğrultuda Borsa İstanbul kotunda kimya sektöründe faaliyet gösteren 20 firma, dinamik panel veri yöntemlerinden sistem GMM yöntemi kullanılarak analiz edilmiştir. Çalışma sonucunda, Ar-Ge giderlerinin firmaların finansal performansını, bir yıl gecikme ile pozitif ve anlamlı olarak etkilediği sonucuna ulaşılmıştır.

Anahtar Sözcükler: *Araştırma ve Geliştirme, Firma Performansı, Kimya Sektörü, Dinamik Panel Veri Analizi, Sistem GMM*

1.INTRODUCTION

In globalized markets, firms have to develop various strategies to provide a competitive advantage and to increase market value and profitability. Otherwise, intense competition and rapidly changing technology corrodes the added value of existing goods and services (Gunday et al., 2011:662). This necessitates the firms to develop new products and services and produce specially commercially viable ideas and act innovative (Ehie and Olibe, 2010:128).

"*Innovation involves the utilisation of new knowledge or a new use or combination of existing knowledge*"(Oslo Manual, 2005:39). Thus, innovation and development, in other words, activities conducted to obtain new products and services are named as innovation oriented activities (Çiçek and Onat, 2012:48). Innovation activities are generally fueled with R&D spending. It is claimed that R&D investments provide product and process innovation and innovation in turn increased productivity and economic performance (Crepon et al., 1998:3). In short, innovation could be expressed as the transformation of the knowledge created by R&D into commercial value.

Through R&D investments that are intangible fixed asset investments, firms could create new market share in new markets and new profit areas, hence increasing their performance (Ayaydın and Karaaslan, 2014:34). However, R&D activities should be conducted parallel to other business activities. For these activities to succeed, effectiveness of commercialization is also vital (Martin, 2015:441). On the other hand, in addition to the positive added value they create, R&D investments increase the overall costs of the firms. Cost of innovation includes the costs of creation of the innovation, development and commercialization (Martin, 2015:441). Due to the facts that R&D costs constantly increase and businesses increasingly become more technology dependent to gain competitive advantage, the effect of R&D investments on corporate performance attract more attention among corporate management and researchers (Ayaydın and Karaaslan, 2014:24).

Increasing national and global competition during recent years resulted in increasing number of studies that scrutinized national policies that promote R&D and innovation activities and indirectly their effect on the economic development of the nations. In many of these studies conducted in different countries and industries by several researchers, the positive effect of innovation on performance and profitability is evidenced (Ehie and Olibe, 2010; Sher and Yang, 2005; Parcharidis and Varsakelis, 2007; Gunday et al., 2011; Zhu and Huang, 2012; Griliches, 1985).

Thus, the objective of the this study is to investigate the effect of R&D expenditures on financial performances of the firms. Studies that investigate the relationship between R&D expenditures and performance in Turkey usually focused on manufacturing, technology and

information technology industries (Gunday et al., 2011; Ayaydın and Karaaslan, 2014; Çiçek and Onat, 2012). Different from previous studies, this study aims to scrutinize the effect of R&D spending by Turkish chemical industry corporations on their financial performances. Chemical industry produces intermediate goods for several industries from pharmaceutics to electronics. For this reason, chemical industry innovation activities benefit other industries and the economy as a whole as well (Finger, 2008:3; Aboody and Lev, 2001:4). However, high risks and uncertainty inherent in R&D investments are augmented in chemical industry with R&D projects that finalize after many number of years. Furthermore, the shelf life of most chemical industry products are under 15 years (Kimya Sanayi Rekabet Gücü Raporu, 2012:13). As a result, it is of utmost importance for the chemical industry that R&D expenditures have positive impact on corporate performance.

2.CHARACTERISTICS OF R&D INVESTMENTS

Today, the share of intangible assets in the total assets of the firms increase rapidly. The factors that provide a competitive edge for corporations, increase the corporate value are no longer only their assets, but product and service branding, consumer perception, patents, licenses and R&D activities (Ehie and Olibe, 2010:128; Çiçek and Onat, 2012:47). R&D activities as intangible asset investments provide corporate assets that would result in long-term growth and competitive advantages.

R&D investments have certain unique characteristics. One of the most important ones is the high risk they carry due to the high level of uncertainty about their future returns. R&D activities require initial advanced technology investments. The next stage is the successful commercialization of R&D activities, and then, receiving returns that exceed investment costs (Westerberg, 2014:4). All these factors increase the risk of the required cash flow and the cash flow that would be obtained by the R&D investments.

On the other hand, more than half of all R&D investments are salaries and expenses of specialist employees and engineers. Thus, the value of R&D investments is embodied in these employees. Furthermore, these employees become experienced in their scientific research fields in time and develop accumulated research abilities (Hall, 2002:4; Coad and Roa, 2007:2).

R&D investments are also considered as the determinant of the risk of entering the industry. When corporations that are dominant in the industry increase R&D investments, their competitive advantage in new products and processes increase and the risks that potential entrepreneurs would face increase as well (Stonebraker, 1976:37). On the other hand, scale economies, which is another obstacle against entering the industry, emerge as a result of R&D investments. As mentioned above, this due to personnel and equipment requirements of R&D investments in addition to their cost and risks (Grabowski and Mueller, 1978:335; Henderson and Cockburn, 1993:4).

There are certain advantages in favor of large firms in conducting R&D activities. Imperfections in capital markets provide advantages for large companies in financing risky R&D projects. This occurs due to the fact that presence and consistency of internally-generated funds are related to the size. Furthermore, firms with high sales volume could obtain high R&D returns since they could distribute fixed costs. In addition, large corporations support R&D investments with non-production activities such as marketing, financial planning and as a result acquire more productive results from R&D activities (Cohen and Levin, 1989:1067). Company size – due to positive and negative economies of scale – is considered as an important determinant of R&D. Thus, large companies position themselves better to conduct successful R&D activities (Schumpeter, 1976 cited by Kim et al., 2004:2).

R&D investments differ from other investments based on financing decisions as well. R&D intensive companies usually prefer equity capital financing and thus, a negative correlation between R&D intensity and financial leverage level emerges. This is due to the difference that occurs between capital costs based on its supply from internal or external sources, taxation or non-taxation reasons or the type of the investment (tangible and intangible investments) (Hall, 2002:7). Internal resources are preferred in financing R&D investments for particular reasons. R&D investments create an asymmetric information problem between the debtor and the creditor due to the uncertainty of the outcome, and as a result, moral hazard and adverse selection problems emerge. Furthermore, financers of R&D investments, primarily the banks, could be unwilling to finance these investments (Ughetto and Torino, 2008:6; Czarnitzki and Kraft, 2004:6). On the other hand, borrowing costs vary based on the collateral assets. Firms that possess assets that could be provided as collateral utilize this advantage and could borrow more. However, since R&D investments are not valued based on their real values when provided as collateral, they do not possess the characteristics of a collateral that could secure borrowing and are not accepted as collateral under certain circumstances. This increases borrowing costs of R&D intensive corporations and make it difficult for them to find loans from financial institutions (David et al., 2008:165; Ho et al., 2004:413). Furthermore, in case of financial troubles, leverage effect could be more harmful for R&D intensive companies. This is due to the fact that market value of these type of companies mainly depend on future growth opportunities and they would be unable to sustain R&D investments as a result of the effect of financial troubles on the reduction of their cash flow (Hall, 2002:11). On the other hand, it is argued that equity capital financing has advantages since it does not require collateral, does not cause problems related to financial troubles and does not create inverse selection problem (Brown et al., 2007:5). Hall (2002) claimed that firms preferred to finance R&D investments with internal resources due to the risks they entail. Çiftçi and Cready (2011) reported that leverage level decreased with R&D intensity and this is

consistent with the low borrowing capacity of intangible assets. Ho et al. (2004) suggested that R&D intensive corporations had lower financial leverage, however, they displayed no differences in operating leverage when compared to other firms.

3.LITERATURE REVIEW

Innovation includes developments and new applications that are conducted to introduce novelties in economic fields. Innovation emerges as a result of R&D activities and increases profitability and profits sustain the R&D activities (Gunday et al., 2011:663; Bogliacino and Pianta, 2010:3).

Innovation and indirectly R&D investments bear critical significance for firms to gain and sustain competitive advantage and increase their performances within dynamic environmental conditions (Sher and Yang, 2005:3). Firms gain more competitive advantages and market share based on the importance they assign to innovation (Gunday et al., 2011:663). R&D investments cause firms to reduce their costs, increase market share and drive monopolistic profits (Parcharidis and Varsakelis, 2007:3; Belderbos et al., 2004:11), develop sustainable competitive abilities (Zhu and Huang, 2012:916) and sustain long-term growth increase their profits by differentiating their products, improve existing products and develop new products, and thus, increase their performance (Salim and Bloch, 2009:4). Furthermore, R&D activities conducted in a corporation could affect productivity performances of other companies in the same or different industries – national or international (Hall et al., 2009:3). This is called the spillover effect of R&D. As a result, productivity of a nation depends on R&D efforts of other countries as well as its own R&D efforts especially due to the effect of globalization (Krammer, 2010:14). An innovation discovered in a firm, industry or nation could open new paths of research, promote new research projects or could find new application areas in other firms, industries or nations. Henderson and Cockburn (1993) indicated that spillover effect between the companies has a significant role in the increasing R&D productivity.

The desire to determine whether R&D investment returns are worth the high costs required for investment increased the interest of individuals from diverse fields such as corporate management, politics and academy, etc. on the subject during recent years (Hall et al., 2009:3). Thus, several studies that investigated the effect of R&D expenses on corporate performance are conducted. As a result of the study conducted by Griliches (1985) on manufacturing industry firms in the USA, it is reported that R&D positively contributed to the performance increase and caused high returns. As a result of the study they conducted with Taiwan firms, Sher and Yang (2005) argued that high R&D intensity and high R&D manpower are the determinants of developed corporate performance. As a result of the study they conducted in Swedish manufacturing industry, Johansson and Lööf (2008) found that the performances of firms that continuously invested in R&G are higher

than those that invested in R&D from time to time and never invest in R&D. Ehie and Olibe (2010) conducted a study with US manufacturing and service industry firms and claimed that R&D positively affected corporate performance positively even during periods of major economic problems. Shin and Kim (2011) found that the innovative enterprises can maintain higher firm value by innovation activities such as R&D expenditures. Kocamış and Güngör (2014) found positive and significant correlation between R&D expenditures and profitability indicators of firms traded in Bourse Istanbul. In a study they conducted with information and technology firms traded in Bourse Istanbul, Çiçek and Onat (2012) claimed that R&D expenditures affected corporate performance positively. Gunday et al. (2011) studied 184 Turkish manufacturing firms and demonstrated the positive effect of innovation on corporate performance in the manufacturing industry. Ayaydın and Karaaslan (2014) analyzed manufacturing firms quoted in Bourse Istanbul and reported that R&D expenditures had a positive effect on financial performances of the firms. Karacaer et al. (2009), analyzed 84 firms quoted in Bourse Istanbul and concluded that there is a positive and statistically significant correlation between R&D expenditures and firm performance.

4.CHEMICAL INDUSTRY

Chemical industry bears great significance for consumers, other industries and national economy by reaching the consumers with 30% of its products and providing intermediate goods or raw materials with 70% of its production for other industries (Kimya Sektörü Raporu, 2015:5). R&D activities in the chemical industry leads to innovation in several industries indirectly. Thus, differentiation and added value creation of chemical industry firms are quite important for creating a national competitive edge.

Chemical industry is a pioneer in R&D activities. The first industrial R&D laboratories are established in the chemical industry in the 19th Century. In addition, various innovations such as plastic, polyester, silicone PVC, polyethylene, synthetic leather, lycra, quartz crystal, liquid crystal are developed by the chemical industry during the 20th century (Freeman and Soete, 1997 cited by Aboody and Lev, 2001:2).

Today, one of the most important requirements for the chemical industry is the advanced technology products. This doubles the significance of R&D and innovation for the industry (Kimya Çalışma Grubu Raporu, 2015:25). Although chemical industry is very important for all industries and national economy with its R&D investments, it failed to attract interest when compared to other innovative sectors. According to Chemical Industry Report-2015, one of the most important threats against the industry is the insufficiency of R&D investments in the industry.

Turkish chemical industry is one of the major import sectors due to the insufficiency of domestic production. Petroleum products consist the bulk of imported intermediary goods. Against rapidly increasing domestic demand, national product supply is far from sufficient due to limited volume of investments. Thus, national and international competitiveness of the chemical industry is adversely affected and causes the added value to remain in foreign countries (Kimya Sektörü Raporu, 2015:5).

R&D investments in chemical industry inherits positive externalities that contribute to technological and scientific developments in pharmaceutics, biotechnology, agriculture, textile, transportation, and food industries. Thus, in addition to the contributions of R&D investments in chemical industry to the productivity of the firms in this industry, attention should also be paid to its contributions to other industries and society (Aboody and Lev, 2001:6).

There are limited number of studies that investigated the effect of R&D investments on corporate performance in chemical industry. Findings of the study conducted by Aboody and Lev (2001) in the US chemical industry demonstrated that R&D activities conducted in chemical industry resulted in high productivity. Furthermore, they reported that returns on R&D investments are higher than capital costs and R&D contributed to corporate growth and creating value. In the study conducted by Fortune and Shelton (2014) with global chemical products industry, it is argued that R&D positively affected corporate performance and this impact is greater in older firms.

5.METHODOLOGY

In this study, the effect of R&D expenditures on corporate performance is analyzed with the dynamic panel estimation model of Generalized Moments Method system analysis. Dynamic panel estimation methods are designed for conditions where 1) there are small number of time periods and large number of units (T < N), 2) there is a dynamic dependent variable and is affected by past conditions, 3) there is a linear functional correlation, and 4) independent variables are not totally external (Roodman, 2009:86). In dynamic methods, lagged value of the dependent variable is included in the model as independent variable. General expression of dynamic models is as follows (Baltagi, 2005: 135):

$$Y_{it} = \delta Y_{i,t-1} + X'_{it}\beta + u_{it} \qquad i = 1, \ldots . N \quad t = 1, \ldots \ldots T$$

where i depicts units and t depicts the time and it is the times series dimension of the panel data. Y_{it} is the dependent variable vector, X_{it} is the explanatory variables vector, is the

parameter vector, μ_i is unobserved unit specific effect, and u_{it} is the error term. Error term is expressed as follows:

$$u_{it} = \mu_i + \varepsilon_t + \nu_{it}$$

One of the problems caused by the lagged dependent variable in the model is the emerging correlation between $Y_{i,t-1}$ and the error term. This fact causes ordinary least squares (OLS) and generalized least squares (GLS) methods generate inconsistent and biased results in dynamic panel data models. An alternative method to resolve this problem is to conduct first difference conversion of the individual effect. Methods that produce consistent estimators alternative to OLS and GLS methods are proposed by Anderson and Hsiao (1982) and Arellano and Bond (1991). Generalized moments method (GMM) developed by Arellano and Bond utilizes all probable lags that could be observed in dependent and independent variables as instrumental variable and provides more effective estimations when compared to Anderson and Hsiao (1982) (Baltagi, 2005:136).

Difference GMM developed by Arellano and Bond (1991) and System GMM developed by Arellano and Bover based on generalized moments method are commonly used for the analysis of panel data models. Blundell and Bond (1998), Blundell, Bond and Windmeijer (2000) reported that system GMM estimator is superior in bias and effectiveness when compared to other widely used estimators including difference GMM (Soto, 2009: 10). Furthermore, Soto (2009) compared the power of system GMM and difference GMM in small samples using Monte Carlo simulation and demonstrated that system GMM is the most active estimator with the lowest deviation.

6.MODEL AND VARIABLES

The analysis is conducted with System GMM method and STATA software program. Econometric models utilized in the study are displayed below.

$ROA_{it} = \alpha_0 + \beta_1 ROA_{it-1} + \beta_2 R\&D\ intensity_{it} + \beta_3 Size_{it} + \beta_4 Financial\ Leverage_{it} + \varepsilon_{it}$ (1) $ROE_{it} = \alpha_0 + \beta_1 ROE_{it-1} + \beta_2 R\&D\ intensity_{it} + \beta_3 Size_{it} + \beta_4 Financial\ Leverage_{it} + \varepsilon_{it}$ (2)

Model variables are as follows:

ROA_{it} : *t* period return on assets for company *i*

ROA_{it-1} : *t-1* period return on assets for company *I*

ROE_{it} : *t* period return on equity for company *I*

ROE_{it-1} : *t-1* period return on equity for company *i*

R&Dit : R&D intensity

SZit : Company size

FLit : Financial leverage rate

In the models, *i* represents chemical industry firms and *t* depicts the time period. Corporate performance is the dependent variable in the model. In the measurement of corporate performance, accounting based indicators are considered as important criteria.

ROA and ROE dependent variables are determined as corporate performance criteria in the present study, consistent with other studies in the literature.

R&D intensity if the independent variable in the model. R&D intensity is calculated by dividing R&D expenditures by gross sales. Since R&D activities create revenues in the future, they affect corporate performance with a few years of lag (Zhu and Huang, 2012:916 ; Aboody and Lev, 2001:23). Parcharidis and Varsakelis (2007) suggested that there is a negative correlation between R&D expenditures and profitability on the year of investment, however, only two years after the investment this correlation changed in a powerful and positive direction. Zhu and Huang (2012) reported that firms following a R&D intensive investment strategy demonstrated significantly higher financial performance one year after the investment. Belderbos et al. (2004) argued that the effect of innovation strategies on productivity is sensitive to lag. Consistent with the literature, effect of R&D expenditures on corporate performance is analyzed with a one year lag. Model control variables are company size and financial leverage.

Aboody and Lev (2001) reported that the effect of the economies of scale is significant in chemical industry. Company size, calculated by taking natural logarithm of total assets, is used to control the effect ıf positive and negative economies of scale.

Financial leverage is calculated with division of total liabilities by total assets. Financial leverage is used to control cross-sectional variation the emerges due to capital structure differences in firm assessment and it is an alternative ratio to the company risk (Ehie and Olibe, 2010: 130).

7. EMPIRICAL FINDINGS

In the present study that examines the effect of R&D expenditures on financial performance of the corporations, 2001 – 2014 financial statement data for 20 Turkish chemical industry firms are utilized. 2001 – 2008 financial statement data are obtained from Public Disclosure Platform (KAP) web site and 2008 – 2014 data are obtained from Bourse Istanbul (BIST) web site.

Correlation matrix between the variables sued in the study is presented in Table 1 below.

Table.1 Correlation coefficients among the variables

	ROA_{it}	ROE_{it}	$R\&D_{it}$	FL_{it}	SZ_{it}
ROA_{it}	1				
ROE_{it}	0.05	1			
$R\&D_{it}$	-0.20	-0.07	1		
FL_{it}	-0.35	0.05	0.07	1	
SZ_{it}	0.26	-0.09	0.02	-0.21	1

Table 1 demonstrates that, consistent with the literature, there is a positive correlation between R&D expenditures and size based on corporate performance. This supports the view that larger firms spend more on R&D. Furthermore, it is observed that there is a negative correlation between financial leverage and return on assets.

Descriptive statistics on the variables is presented in Table 2.

Table.2 Descriptive Statistics

	Mean	*Median*	*Max.*	*Min.*	*Std. Dev.*
ROA_{it}	0.041	0.041	0.454	-0.355	0.087
ROE_{it}	0.136	0.097	23.38	-13.99	1.717
$R\&D_{it}$	0.003	0.000	0.026	0	0.005
FL_{it}	0.503	0.435	2.018	0	0.303
SZ_{it}	19.80	19.66	23.81	16.81	1.344

System GMM analysis requires the test of estimation results for consistency. For this purpose, three different tests are conducted. The first test conducted is Hansen test. Hansen test, used to measure the validity of instrumental variables. Hansen tests' null hypothesis of "instrumental variables are valid" shouldn't be accepted at 5% significance level. The second line of tests are AR(1) and AR(2) tests proposed by Arellano and Bond (1991) to test autocorrelation in dynamic panel data models. AR(1) and AR(2) tests, test the basic hypothesis that "there is no autocorrelation of the first and second degree." For the activity of GMM estimators, null hypothesis should not be rejected at 5% significance level (Tatoğlu, 2013: 101). The third test is the Wald test that tests whether the model is significant as a whole. For the model to be considered significant, H0 hypothesis should be rejected at 5% significance level.

System GMM estimation results are presented in Tables 3 and 4.

Table 3 : System Dynamic Panel Data Estimations With ROA

Dependent variable: ROA	*Coefficient*	*p-values*
Constant	-0.1409	0.021
ROA_{it-1}	0.2281	0.003
$R\&D_{it-1}$	5.7158	0.017
FL_{it}	-0.0295	0.003
SZ_{it}	0.0160	0.002
Observations	260	
Wald test	104.61 (*p*-	
Hansen test	13.84 (*p*-	
Difference- Hansen	1.06 (*p*-	
AR(1)serial	-2.74 (*p*-	
AR(2)serial	0.38 (*p*-	

Table 3 demonstrates that the model is significant as a whole based on Wald test results. Based on AR(1) and AR(2) test results used to test autocorrelation of the first and second degrees, it is observed that there is a negative autocorrelation on the first degree and there is no autocorrelation on the second degree. Tatoğlu (2013) indicated that non-existence of a 2nd degree autocorrelation is important for the generalized moments estimator to be active. Thus model seem suitable. Based on difference-Hansen test results, H0 hypothesis could not be rejected. Thus, instrumental variables used in the model are valid.

According to Table 3, 1 unit increase in previous year's return on assets affects the current year return on assets positively and 0.2281 unit. Similarly, 1 unit increase in previous year's R&D expenditures increased current year return on assets 5.71 units. This finding confirms the positive correlation between R&D expenditures of the firms and corporate performance. Analysis results showed that there is a negative correlation between financial leverage and return on assets. One unit increase in financial leverage degree decreased return on assets with a ratio of 0.029. It could be observed that there is a positive correlation between company size and return on assets.

Table 4 : System Dynamic Panel Data Estimations With ROE

Dependent variable: ROE	*Coefficient*	*p-values*
Constant	-0.2562	0.012
ROE_{it-1}	0.0515	0.000
$R\&D_{it-1}$	8.4440	0.000
FL_{it}	-0.3406	0.000
SZ_{it}	0.0237	0.000

Observations	260	
Wald test	66268.9	(*p*-
Hansen test	16.09	(*p*-
Difference- Hansen	-0.72	(*p*-
AR(1)serial	-1.05	(*p*-
AR(2)serial	-0.93	(*p*-

Table 4 demonstrates that the model is significant as a whole based on Wald test results. Based on AR(1) and AR(2) test results, it is observed that there are no autocorrelations on the first degree and second degree. Based on difference-Hansen test results, H0 hypothesis could not be rejected, thus, it is concluded that the instrumental variables are valid.

According to Table 4, the effect of one year lagged R&D expenditure value on return on equity is positive and statistically significant. Accordingly, one unit increase in previous year R&D expenditures increased current year return on equity by 8.44 units. Analysis results demonstrated that, similar to Table 3, there is a positive correlation between company size and return on equity, while there is a negative correlation between financial leverage and return on equity.

8.CONCLUSION

This study investigated whether R&D expenditures had a positive effect on corporate financial performance empirically. For this purpose, financial statement data for 20 Turkish chemical industry firms are analyzed with dynamic panel data estimation model of generalized moments method system model. Return on assets and return on equity ratios are used as corporate performance indicator and dependent variable in the study. Furthermore, two control variables of financial leverage and company size are determined. Conducted econometric analysis demonstrated that there is a positive and significant correlation between financial performance of chemical industry firms and their company size. In addition, it is found that financial leverage degree affected corporate performance negatively.

Finally and consistent with the literature, it is determined that R&D expenditures in chemical industry affected both return on assets and return on equity positively and significantly after a one year lag. Since R&D activities are long-term investments, returns on investments could take a few years to realize. In other words, transformation of a new idea into a product/service with new techniques and information technologies, commercialization of this product/service and high investment costs results in the positive returns of R&D investments to occur only one or a few years after the original investment.

This study aims to address the significance of R&D activities in general and R&D activities in the chemical industry and sustainability of these activities in particular. Since chemical industry products reach both end consumer and other industries, it is possible to create added value for all parties in the economy through R&D activities in this industry. Particularly in Turkey, chemical industry reports demonstrated that R&D activities in the industry is significantly below the world average. Thus, it is considered important for all parties in the economy to increase R&D activities in Turkish chemical industry and catch up with the world standards.

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