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Research Article / *Araştırma Makalesi*

R&D SPENDING AND FINANCIAL PERFORMANCE: AN INVESTIGATION IN AN EMERGING MARKET

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ABSTRACT

The study aims to investigate the relationship between the R&D spending of twenty-five industrial sub-sectors consisting of the largest 500 industrial firms of Turkey and their financial performances between 2013 and 2019. In this context, the effect of current and lagged R&D spending of the sub-sectors on return on assets (ROA), return on equity (ROE), and return on sales (ROS) analyzed with panel data models. As this study is one of the first to explore the relationship between R&D spending at the sectoral level data in a developing country such as Turkey and financial performance, it holds importance. The findings of the study demonstrate that current year R&D spending of the sub-sectors affect their financial performance negatively and this impact turns positive after a year. However, this positive effect cannot be preserved and turns back to negative in the long term. The robustness test also supports these empirical findings. Therefore, it is suggested that R&D spending should be made steadily and the industrial sector should focus on the long-term returns of R&D spending to sustain the positive impact on financial performance.

Keywords: *R&D Intensity, Profitability, Lagged Effect, ISO 500, Turkey.*

AR-GE HARCAMALARI VE FİNANSAL PERFORMANS: GELİŞMEKTE OLAN BİR ÜLKE ÜZERİNE ARAŞTIRMA

ÖZET

Bu çalışmanın amacı, 2013-2019 yılları arasında Türkiye'nin en büyük 500 sanayi şirketinin oluşturduğu yirmi beş sanayi alt sektörünün Ar-Ge harcamaları ile finansal performansları arasındaki ilişkiyi incelemektir. Bu bağlamda çalışmada, alt sektörlerin cari ve gecikmeli Ar-Ge harcamalarının sektörlerin aktif kârlılığı (ROA), özsermaye kârlılığı (ROE) ve net kâr marjı (ROS) üzerindeki etkisi panel veri modelleri ile analiz edilmektedir. Çalışma, Türkiye gibi gelişmekte olan bir ülkede sektörel düzeyde Ar-Ge harcamaları ile finansal performans arasındaki ilişkileri inceleyen ilk çalışmalardan birisi olması nedeniyle önem arz etmektedir. Çalışmanın bulguları, alt sektörlerin cari yıl Ar-Ge harcamalarının finansal performanslarını negatif etkilediğini ve bu etkinin bir yıl sonra pozitife döndüğünü göstermektedir. Ancak, bu pozitif etki korunamamakta ve uzun dönemde tekrar negatife dönmektedir. Sağlamlık testi de bu ampirik bulguları desteklemektedir. Bu nedenle, Ar-Ge harcamalarının finansal performans üzerindeki pozitif etkisinin sürdürülebilmesi için bu harcamaların istikrarlı olarak yapılması ve sanayi sektörünün yapılan Ar-Ge harcamalarının uzun vadeli getirilerine odaklanması önerilmektedir.

Anahtar Kelimeler: *Ar-Ge Yoğunluğu, Kârlılık, Gecikme Etkisi, ISO 500, Türkiye.*

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1. Introduction

Economic theory and empirical studies indicate that research and development activities are one of the key factors in increasing long-term economic growth (Romer, 1990; Aghion & Howitt, 1992; Grossman & Helpman, 2001). Thus, developing countries are expected to prioritize R&D activities to accelerate economic growth and avoid getting caught into the middle-income trap. To maximize the potential effect of R&D spending on economic growth and development, the efficiency and effectiveness of these kinds of expenditures should be ensured (Alam et al., 2020). In this regard, Pindado et al. (2010) and Xu et al. (2019) suggest that larger firms might be more successful in carrying out R&D activities, the reason being is that these firms usually have higher financial performance and sufficient financial resources compared to smaller firms to make R&D spending. Furthermore, they effectively manage fixed costs with high sales volume and gain greater earnings from R&D activities by supporting R&D expenditures with non-production activities such as marketing and financial planning (Pindado et al., 2010; Alper & Aydoğan, 2016; Gui-long et al., 2017; Ozkan, 2018; Xu et al., 2019).

Nowadays, relatively less is known about the impact of R&D spending on financial performance at the sectoral level both in Turkey and in other developing and developed economies despite the non-negligible importance of R&D expenditures (Ameer & Othman, 2020; Hirschey et al., 2012). In this regard, the contributions of the study to the literature discussed as follows. First, this study originates from the lack of empirical findings regarding the impact of R&D spending on the financial performances of industrial sub-sectors within the context of the industrial sector constituted by the largest 500 firms of Turkey. There are studies in the literature that investigate the relationship between R&D expenditures of firms operates in different sectors and their financial performances by assorting the firms by their sectors. The findings of these studies propose that according to the sector firms operate, R&D expenditures might have a positive, negative, or no impact on the financial performances of the firms (Goto & Sueyoshi, 2008; Ehie & Olibe, 2010; Koku, 2010; Shin et al., 2017). Second, considering that R&D spending is being made frequently by larger firms and the industrial sector in the business world, this study focuses on a dataset containing twenty-five industrial sub-sectors consisting of the largest 500 industrial firms in Turkey. Particularly, the latest studies indicate the importance of developing countries within the world economy and the fact that R&D expenditures grow even faster in these countries (Alam et al., 2020). Third, this study, conducted in a developing country such as Turkey at the sectoral level, may contribute to the literature. Additionally, there isn't any particular consensus on the effect of R&D spending on current year financial performance indicators in the light of the findings at the firm level in the literature. Even though various studies argue that this effect is positive (Sher & Yang, 2005; Gui-long et al., 2017; Paula & Silva Rocha, 2020), studies in recent years claim that this effect is negative in the initial years and positive in the following years (Chen et al., 2019; Liu et al., 2019; Xu et al., 2019; Alam et al., 2020). In other words, R&D spending might have a lagged effect on financial performance. Presenting sectoral level findings regarding whether R&D spending has a lagged effect on current year financial performance is fourth contribution of this study to the literature. The findings of the study indicate that the R&D spending of the industrial sector is quite low and current year R&D expenditures affect the current year financial performance negatively, however, there is a one-year lagged positive effect of R&D expenditures. Therefore, it can be said that R&D spending have a one-year lagged positive effect on financial performance in industrial sub-sectors. On the other hand, this lagged positive effect cannot be sustained and two-year lagged R&D expenditures have a negative effect on the current year's financial performance. For that reason, the commonly accepted opinion suggesting that R&D spending has a lagged effect should be made with caution and long-term effects should be considered.

The study consists of six sections. In the second section following the introduction, studies in the literature analysing the relationship between R&D spending and financial performance are mentioned. In the third section, the hypotheses are built upon the findings in the economics and finance literature. In the fourth section, the data, variables, and methods used in the study are stated. In the fifth section, the empirical findings of the study are demonstrated. In the last section, the results of the study are summarized and discussed, and suggestions for further research are provided.

2. Literature Review

2.1. R&D Activities

Research and development (R&D) have many definitions in the literature. Many researchers use the description contained in the Organization for Economic Cooperation and Development's (OECD) Frascati Guide. According to this definition, R&D is: "R&D comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture, and society – and to devise new applications of available knowledge." In this guide, the OECD lays out five criteria for determining R&D. Accordingly, the five criteria included in R&D activities are as follows: (1) novel, (2) creative, (3) uncertain, (4) systematic, and (4) transferable and/or reproducible (OECD, 2015). International Accounting Standards-38 (IAS-38) and Turkish Accounting Standards-38 (TMS-38) define research as is an original and planned investigation with the prospect of gaining new scientific or technical knowledge and understand; though development is the application of research findings or other knowledge to a plan or design for the production of new or substantially improved materials, devices, products, processes, systems, or services, before the start of commercial production or use. The common point of these definitions is that R&D is the activities carried out by firms to innovate and offer new products and services. In this context, R&D activities contribute to the profitability of firms by enabling them to stay one step ahead of global competition (Ballester et al., 2003; Yıldız, 2003; Karacaer et al., 2009; Koku, 2010; Esin, 2015).

R&D is different from other operational activities of firms and cannot increase the firm's profitability immediately. Instead, it might have a positive effect on the long-term profitability and survival of firms. As firms continue their R&D activities, they might make new inventions and products, which turn into patents, copyrights, and trademarks. However, the return on these expenditures for R&D activities is uncertain. For this reason, the risk of firms also increases as R&D expenditures rise (Artz et al., 2010; Chircop et al., 2020; Nkundabanyanga et al., 2020).

R&D activities might positively affect the profitability of firms but are still considered an expense. This is because firms spend huge sums on research and developing new products and services. Therefore, the expenditures made for R&D take their place in the accounting reports. Here, firms record research expenses as they occur, while they might carry forward development expenses (Esin, 2015).

2.2. R&D Spending and Financial Performance

Lately, the interest of academic, commercial, and political environments in the effects of R&D spending on sectors and firms has been constantly growing. R&D spending increasing productivity and contributing to the economic growth of the country and firm performance via technological advances lie behind this growth (Zang et al., 2019). Even though there are four different indicators of firm performance being innovative performance, production performance, market performance, and financial performance within this framework (Gunday et al., 2011); this study concentrates on the research investigating the relationship between R&D spending and financial performance.

In the literature, the financial performances of the firms are measured by market-based or accounting-based indicators (Bae et al., 2008). In the studies containing market-based financial performance indicators, the effect of R&D spending on firm value is investigated (Ehie & Olibe, 2010). In order to represent firm value, those studies use different variables such as Tobin's q ratio, market value, market to book ratio, stock return, and abnormal returns (Bae et al., 2008; Demirgüneş & İltaş, 2020). In this context, initial studies point out that R&D spending affects firm value positively (Griliches, 1981; Connolly & Hirschey, 1984; Jaffe, 1986; Chauvin & Hirschey, 1993; Johnson & Pazderka, 1993). On the contrary, Chan et al. (2001) argue that R&D spending and their stock returns in the future do not have a linear relationship. In this regard, researchers show that portfolios made up of stocks of firms invest in R&D convey similar returns compared with portfolios made up of stocks of firms that do not invest in R&D. Eberhart et al. (2004) also claim that the market responds less than expected to the increase in R&D spending and the benefit of this spending reflected in the market values of the firms in the long term. Supporting this remark, Lee & Choi (2015) also state that R&D spending made in the past years affect firm value positively. In other studies, the effect of the features of the firms on this relationship is taken into consideration. For instance, Pindado et al. (2010) suggest that features such as the size of the firm, firm growth, and market share affect the relationship between R&D spending and firm value positively; and features such as free cash flow, dependence on external finance, labour density, and capital intensity affect this relationship negatively. Similarly, Bae et al. (2008) emphasize that R&D spending of international firms has an even stronger positive effect on market values. Correspondingly, Vithessonthi & Racela (2016) also point out that as the degree of internationalization gets higher, the positive effect of R&D intensity on firm value gets stronger. Ehie & Olibe (2010) investigated the effect of R&D spending of firms operates in different sectors on market value. The researchers demonstrate that R&D spending had a stronger positive effect on market values of manufacturing industry firms compared to service industry firms before the 9/11 attacks; however, things went in service industry firms' favour after 9/11. In addition to these, studies in recent years investigate whether R&D spending and firm value have a non-linear relationship. In this context, Bae et al. (2008) argue that the relationship between R&D spending and firm value is initially negative, then positive, and then negative again according to the internationalization degree of the firms. Kim et al. (2018) and Naik (2014) claim that the relationship between R&D intensity and firm value could be expressed as an inverted-U curve. In other terms, the researchers state that initially, firm value increases as R&D spending increase; however, this spending start to lower the market value of the firm after a particular level. Chen & Ibhagui (2019) also suggest that there is a predicted threshold value for R&D intensity and that values of R&D intensity lower than this threshold affect market value positively, and values of R&D intensity higher than this threshold might either have no effect or a negative effect.

The effect of R&D spending on return on assets, return on equity, return on sales, and sales growth is analysed in studies that use accounting-based financial performance indicators (Bae et al., 2008). In the literature, a debate has been going on about how and in what way R&D spending affects accounting-based financial performance indicators (Wang, 2011). Some studies emphasize that current year R&D spending has a positive effect on financial performance; however, others argue that they either have no effect or a negative effect. The ones claiming that there is a positive effect mention the importance of strategic competitive advantage of R&D spending. For instance, Andras & Srinivasan (2003) suggest that to maintain their operations and maximize their financial performance, the firms should constantly be at a level to compete with other firms in the market. The researchers particularly mention that even though it's troublesome to make R&D spending in a competitive market that has economic distress, these expenditures still have a positive effect on the profit margins of the firms. Paula & Silva Rocha (2020) state that acquiring a competitive advantage by creating new sources of income and reducing costs causes this positive effect. Similarly, Sher & Yang (2005) also argue that innovative R&D spending helps the firms provide rare, inimitable, and differentiated products of great value to the market, causing the firms to have high rates of profitability. Guilong et al. (2017) assert that firms that have higher financial performances have more resources for R&D spending and that these expenditures have an even greater effect on the profit margins of firms that are financially well off. According to Goto & Sueyoshi (2008), the effect of R&D spending on financial performance differs from sector to sector. The researchers suggest that R&D spending has a positive effect on profitability ratios of machine industry firms, whereas a negative effect on the electrical equipment industry firms. Shin et al. (2017) support this proposal by stating that the relationship between R&D spending of integrated firms, gross profit margin, and return on sales is negative; however, this negative relationship is even stronger in firms that do not have factories. Most of the studies stating that R&D spending has a negative effect on profitability ratios argue that this is valid only for the year the expenditures made. Chen et al. (2019) point out that R&D spending is engaged as an expense in the income statement, and therefore, they reduce profitability by increasing the operating expenses of the firm. Correspondingly, recent studies have shown that R&D spending has a lagged effect on financial performance. Similarly, Alam et al. (2020) argue that time is necessary for results such as the development of new production methods after R&D spending, the usage of information technologies in these methods, and the production of innovative products to occur; therefore, indicating that R&D spending will have a negative effect on current year return on assets but this effect will turn positive after a year. Liu et al. (2019) also emphasize that as it takes time for the results of expenditures made for R&D operations and R&D personnel to turn into innovation, they do not instantly generate income and affect the financial performance negatively during the initial years. According to Liu et al. (2019) and Xu et al. (2019), R&D spending starts affecting return on equity and return on assets positively after two years. Chen & Wu (2020) also claim that due to the nature of R&D spending, it causes a lagged effect on return on assets and suggests that this caused by information transfer brought by investment taking a significant amount of time.

It's also possible to come across multiple studies that analyse the relationship between R&D spending of Turkish firms and their financial performances. Overall, the studies are mostly focused on manufacturing industry firms, and technology firms listed in Borsa İstanbul (BIST). Some of the studies analyse the firms one by one (Akgün & Akgün, 2016; Şişmanoğlu & Yaşar Akçalı, 2016). Most of the studies review the period after the year 2000 and use panel data regression analysis methodology. Similar to the international literature, a consensus has not been reached in these studies when it comes to the effect of R&D spending on financial performance indicators (Karacaer et al., 2009; Yücel & Ahmetoğulları, 2015; Aytekin & Özçalık, 2018). While some studies demonstrate a positive relationship between R&D spending and financial performance indicators (Ayaydın & Karaaslan, 2014; Kocamış Uzun & Güngör, 2014; Doğan & Yıldız, 2016; Yıldırım & Sakarya, 2018; Demir & Güleç, 2019), some indicate a negative relationship (Kiracı & Arsoy, 2014; Polat & Elmas, 2016; Güzen & Başar, 2019). According to Altınbay et al. (2017), this is a short-term positive relationship, but Yıldırım & Sakarya (2018) state that this is a long term relationship. Additionally, whether R&D spending has a lagged effect on financial performance indicators or not has also been investigated (Yücel & Ahmetoğulları, 2015; Alper & Aydoğan, 2016; Dağlı & Ergün, 2017; Güzen & Başar, 2019).

3. Research Hypothesis

The effect of R&D spending on financial performance has been investigated for many years. However, these studies are not completely able to show the effect of R&D spending on financial performance. Some studies argue that current year R&D spending affect current year financial performance positively (Andras & Srinivasan, 2003; Sher & Yang, 2005; Gui-long et al., 2017; Paula & Silva Rocha, 2020); however, some of them state that there is a negative effect (Shin et al., 2017; Chen et al., 2019; Liu et al., 2019; Alam et al., 2020). Besides, it is possible to come across studies showing no relationship between R&D spending and financial performance (Zhang et al., 2007; Natasha & Hutagaol, 2009; Hsu et al., 2013). Accordingly, the first hypothesis is:

H1: Current year R&D spending has a negative effect on the current year's industry financial performance.

The effect of lagged R&D spending on the current year's financial performance is another area of research. Because the occurrence of new products and for new production methods and information technologies to yield results take a certain amount of time after R&D spending, current year R&D spending seems unlikely to affect current year financial performance positively. Features distinguishing R&D spending from ordinary investments such as long-term investment horizon, high uncertainty about production, high asset specificity, high failure rate, and high costs also approve this statement (Hall, 2002; Ozkan, 2018; Alam et al., 2020). So, many studies conducted recently also explore the effect of lagged R&D spending on current year financial performance (Chen et al., 2019; Güzen & Başar, 2019; Liu et al., 2019; Alam et al., 2020; Chen & Wu, 2020). On that note, under the expectation that R&D spending might increase sectoral efficiency, decrease costs, provide a sustained income, and therefore yield higher profitability in future years (Pandit et al., 2011; Bond & Guceri, 2017; Yoo et al., 2019); the following two research hypotheses built:

H2: One-year lagged R&D spending has a positive effect on the current year's industry financial performance.

H3: Two-year lagged R&D spending has a positive effect on the current year's industry financial performance.

4. Data, Variable Definitions and Empirical Methodology

4.1. Sample Selection

In this study, the data is obtained from sub-sector balance sheets and income statements of Turkey's Top 500 Industrial Enterprises Survey (ISO 500) conducted by the Istanbul Chamber of Industry (ICI)[1]. ICI publishes the research on an annual basis on its website under the title "ISO 500 Magazines" as specific sectoral aggregates. The data used in this study was taken from the ISO 500 Magazine for 25 industrial sub-sectors and the 2013-2019 period. The ISO 500 research has been utilizing the European Classification of Economic Activities (NACE Rev.2) since 2013. Sectoral level data regarding research and development expenses have not been included in the magazines published before 2013. For that reason, the scope of our study includes the sectoral level data from the years 2013 to 2019 arranged according to NACE Rev.2.

Industrial sub-sectors included in the study and the average number of firms included in the 2013-2019 period in the ISO 500 research to generate the sectoral data are presented in Table 1. Accordingly, the industrial sector analysed in this study includes 25 sub-sectors that have NACE Rev.2 codes ranging between 05 and 35. ISO 500 research involves different numbers of firms every year from every single sub-sector to compose the sectoral level data and uses the top 500 industrial firms. In Table 1, when the percentage distribution of the firms according to industrial sub-sectors for the 2013-2019 period examined, it can be seen that manufacture of food products has the highest sub-sector participation rate in the ISO 500 research with 19.37% (approximately 97 firms). Manufacture of basic metals follows this sub-sector with 14.17% (approximately 71 firms). Manufacture of furniture (approximately 5 firms), other manufacturing (approximately 4 firms), manufacture of computer, electronic and optical products (approximately 4 firms), manufacture of tobacco products (approximately 3 firms), printing and reproduction of recorded media (approximately 3 firms), and manufacture of leather and related products (approximately 1 firm) have numbers of firms making up less than 1%. During the 2013-2019 period, the total of R&D spending of the industrial sector was TRY 3,042.04 million on average, and approximately 64% of these expenditures were made by mining and quarrying (TRY 1,109.73 million), manufacture of motor vehicles, trailers, and semi-trailers (TRY 521.86 million) and manufacture of electrical equipment (TRY 320.39 million) sub-sectors. It can be seen that firms within the manufacture of leather and related products sub-sector have not made any R&D spending in this period. The top three sub-sectors that have the highest R&D intensity are mining and quarrying (6.75%), manufacture of computer, electronic and optical products (2.27%), and manufacture of basic pharmaceutical products and pharmaceutical preparations (1.25%) respectively.

1 ICI conducts the research to determine the largest industrial firms in Turkey as well as provide information for further planning within the industrial field by showing the industrial development in Turkey. The research is based on surveys, and all firms operating within the industrial sector can participate in the surveys voluntarily. The accuracy of the statements of the enterprises is also controlled in the Corporate Income Tax Return (e-return), which includes the year-end balance sheet and income statements prepared following the Tax Procedure Law (TPL) submitted to the Ministry of Finance. This research has been the subject of many theses and research at the academic level so far (http://www.iso500.org.tr/iso-500-hakkinda/tarihce-ve-metodoloji/).

Table 1: R&D Spending for the 2013-2019 Period within the Industrial Sub-Sectors Categorized by NACE Rev.2 Codes (sub-sector averages, TRY million)

NACE Codes	Sub-Sectors	Number of Firms	Sectoral Percentage[a]	R&D Spending (rank)[b]	R&D Intensity Percentage (rank)[c]
05-08	Mining and Quarrying	12.57	2.51	1,109.73 (1)	6.75 (1)
10	Manufacturing of food products	96.86	19.37	189.52	0.23
11	Manufacturing of beverages	6.71	1.34	1.96	0.03
12	Manufacture of tobacco products	3.43	0.69	0.20	0.00
13	Manufacture of textiles	38.71	7.74	38.53	0.16
14	Manufacture of wearing apparel	12.57	2.51	21.30	0.33
15	Manufacture of leather and related products	1.00	0.20	-	0.00
16	Manufacture of wood and of products wood and cork (except furniture)	6.57	1.31	2.33	0.03
17	Manufacture of paper and paper products	14.14	2.83	5.14	0.05
18	Printing and reproduction of recorded media	2.57	0.51	0.36	0.03
19	Manufacture of coke and refined petroleum products	5.00	1.00	38.26	0.06
20	Manufacture of chemicals and chemical products	29.29	5.86	97.22	0.26
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	5.57	1.11	56.26	1.25 (3)
22	Manufacture of rubber and plastic products	20.86	4.17	49.42	0.30
23	Manufacture of other non-metallic mineral products	35.14	7.03	54.60	0.25
24	Manufacture of basic metals	70.86	14.17	21.96	0.02
25	Manufacture of fabricated metal products (except machinery and equipment)	17.71	3.54	93.13	0.75
26	Manufacture of computer, electronic and optical products	4.00	0.80	267.88	2.27 (2)
27	Manufacture of electrical equipment	32.71	6.54	320.39 (3)	0.71

Table 1 continued

28	Manufacture of machinery and equipment n.e.c.	11.57	2.31	76.74	0.68
29	Manufacture of motor vehicles, trailers and semi-trailers	42.14	8.43	521.86 (2)	0.48
30	Manufacture of other transport equipment	6.43	1.29	60.98	0.89
31	Manufacture of furniture	4.86	0.97	14.07	0.35
32	Other manufacturing	4.43	0.89	0.02	0.00
35	Electricity, gas, steam and air conditioning supply	14.43	2.88	0.18	0.00
Total / Average		**500**		**3,042.04**	**0.64**

[a] It indicates the average sub-sectoral participation rate of the firms in the ISO 500 research for seven years.
[b] It indicates the total average sub-sectoral R&D spendings for seven years in the ISO 500 research.
[c] It indicates the total average sub-sectoral R&D intensity for seven years in the ISO 500 research.

4.2. Variables

The variables used in this study calculated by using the balance sheets and income statements of the sub-sectors of the industrial sector. The variables used in the analysis and the calculations for these variables are shown in Table 2. In the study, financial performance is used as the dependent variable and represented by three different variables like return on assets (ROA), return on equity (ROE), and return on sales (ROS). One or more of these profitability measures are used in other studies that take the financial performances of the firms as the dependent variable (Huang & Lui, 2005; Bae et al., 2008; Wang, 2011; Polat & Elmas, 2016; Chen et al., 2019; Alam et al., 2020). Independent variables are divided into two sub-groups: the first one is R&D variables and the second is control variables. R&D intensity (RD_t) is one of the main variables used to represent the innovation levels of the firms and sectors in many studies (Huang & Lui, 2005; Sher & Yang, 2005; Gui-long et al., 2017; Ameer & Othman, 2020), and calculated by dividing the R&D spending of the sector by net sales[2]. Lagged R&D intensity variables (RD_{t-1} and RD_{t-2}) are also found by dividing the relevant years' R&D spending by the relevant years' net sales. In line with the literature (Sharma, 2012; Lee & Choi, 2015; Gui-long et al., 2017; Chen et al., 2019; Zang et al., 2019; Chen & Wu, 2020), we include several control variables in the regression models like sector size (LNTA - natural log of total assets), leverage ratio (LEV - the ratio of total debt to total assets), export rate (EXPSA - the ratio of exports[3] to net sales), and ownership ratios[4] (GOV - public ownership shares and FOR- foreign ownership shares).

Table 2: Variable Definitions

Variable	Empirical Definition	Symbol
Dependent Variables		
Return on Asset	Profit before Tax / Total Assets	ROA

Table 2 continued

Return on Equity	Profit before Tax / Total Equity	ROE
Return on Sales	Profit before Tax / Net Sales	ROS
Independent variables		
R&D Variables		
Current Year R&D Intensity	R&D Expenditures / Net Sales	RD_t
One Year Lagged R&D Intensity	One Year Lagged R&D Expenses / One Year Lagged Net Sales	RD_{t-1}
Two Year Lagged R&D Intensity	Two Year Lagged R&D Expenses / Two Year Lagged Net Sales	RD_{t-2}
Control Variables		
Size	Natural Logarithm of Total Assets	LNTA
Leverage Ratio	Total Debt / Total Assets	LEV
Export Rate	Export / Net Sales	EXPSA
Public Ownership Share	Ownership share of public firms among 500 firms	GOV
Foreign Ownership Share	Ownership share of foreign firms among 500 firms	FOR

4.3. Research Model

Panel data analysis is used to examine the effect of R&D spending on the financial performances of industrial sub-sectors. The equation of the basic panel data model formed in the study is as follows:

$$PERF = \alpha + \beta_1 RD + \beta_2 LNTA + \beta_3 LEV + \beta_6 FOR + \beta_5 GOV + \beta_4 EXPSA + \varepsilon \qquad (1)$$

In Equation (1), PERF represents financial performance indicators (ROA, ROE, and ROS), α represents constant intercept coefficient, β represents the slope coefficients regarding independent variables, and ε represents the error term. Different models formed to determine whether each sectoral financial performance indicator (ROA, ROE, and ROS) are affected by current year R&D spending or lagged R&D spending, and the direction of this effect. To determine these relationships, current year R&D intensity (RD_t), one-year lagged R&D intensity (RD_{t-1}), two-year lagged R&D intensity (RD_{t-2}), and all R&D variables (RD_t, RD_{t-1}, and RD_{t-2},) included in Equation (1) one by one. In this context, a total of twelve models are estimated and three hypotheses (H1, H2, and H3) are tested. The level of R&D alternates, and current year values of other independent variables are taken into consideration in the models. To estimate the models, the F test is used first to choose between classical and fixed effects models, then the Breusch-Pagan Lagrange Multiplier test (BP LM) is used to choose between classical and random-effects models (Liu et al., 2019; Wang, 2011; Yerdelen Tatoğlu, 2012; Zang et al., 2019). If both fixed effects and random effects models are preferred over the classical model, lastly Hausman test is used to decide which of these two models will be selected. To eliminate the possible problems such as heteroscedasticity, autocorrelation, and cross-sectional correlation, models are estimated with robust standard errors (Yerdelen Tatoğlu, 2012).

5. Empirical Findings

5.1. Descriptive Statistics and Correlations

Descriptive statistics regarding every single variable used in the analysis are shown in Table 3. Accordingly, the industrial sector has an average of 6.4% return on assets, 16.7% return on equity, and 8.1% return on sales in the 2013-2019 period. This result indicates that most of the 500 firms within the industrial sub-sectors made a profit in the analysis period. The differences between the minimum and the maximum values of ROA, ROE, and ROS variables point out that the profitability levels of industrial sub-sectors are quite distinct. It is seen that the mean of R&D intensity variables (RD_t, RD_{t-1}, and RD_{t-2}) are at 0.6% both in the current year and the previous two years. In this regard, it can be said that R&D spending in the industrial sector has not changed much in the analysis period. The average leverage ratio is 59.8%, and this means that approximately 60% of the total assets of the industrial sector are financed through loans. The average export rate of the industrial sector is 28.3%, and therefore it is seen that approximately 28% of the sales of the sector are abroad. In the analysed period, public ownership makes up 2.7%, and foreign ownership makes up 19% within the industrial sector.

Table 3: Descriptive Statistics

Variable	Observation	Mean	Std. Dev.	Minimum	Maximum
ROA	173	0.064	0.051	-0.080	0.209
ROE	173	0.167	0.150	-0.431	0.596
ROS	173	0.081	0.086	-0.148	0.561
RD_t	173	0.006	0.016	0.000	0.138
RD_{t-1}	149	0.006	0.013	0.000	0.108
RD_{t-2}	125	0.006	0.013	0.000	0.108
LNTA	173	23.353	1.338	19.517	25.683
LEV	173	0.598	0.140	0.165	0.906
EXPSA	173	0.283	0.175	0.000	0.734
GOV	173	0.027	0.063	0.000	0.351
FOR	173	0.190	0.156	0.000	0.688

Note: All variables are as explained in Table 2.

Table 4 demonstrates the correlation coefficients and variance inflation factors (VIF) values used to assess the multicollinearity problem in-between the independent variables. The correlations between RD_t, RD_{t-1}, and RD_{t-2} variables are quite high (0.783, 0.675, and 0.812 respectively), and they are statistically significant at the 1% significance level. Hence, it suggests that a multicollinearity problem exists in the models (Model 10, Model 11, and Model 12) that use these variables together. However, Ehie & Olibe (2010) state that this is normal in the regression analyses performed to check the effect of interrelated variables on financial performance indicators. Similarly, in many studies (Huang & Lui, 2005; Ehie & Olibe, 2010; Gui-long et al., 2017; Xu et al., 2019), it is accepted that the multicollinearity problem occurs in regression models for VIF values greater than 10. As can be seen in Table 5, all VIF values are lower than 10 (the greatest being 4.13). Furthermore, the greatest VIF value is 1.67 in regression models that use RD_t, RD_{t-1}, and RD_{t-2} variables separately. For that reason, it is concluded that there is no multicollinearity problem in the regression models.

Table 4: Correlation Coefficients between Variables and Variance Inflation Factor Values

	ROA	ROE	ROS	RD_t	RD_{t-1}	RD_{t-2}	LNTA	LEV	EXPSA	GOV	VIF[a]
ROE	0.860***										
ROS	0.770***	0.596***									
RD_t	0.224***	0.079	0.532***								2.62
RD_{t-1}	0.297***	0.123	0.721***	0.783***							4.13
RD_{t-2}	0.284***	0.119	0.657***	0.675***	0.812***						3.08
LNTA	0.059	0.141*	0.075	0.152**	0.154*	0.162*					1.70
LEV	-0.239***	0.136*	-0.299***	-0.211***	-0.216***	-0.203**	0.389***				1.53
EXPSA	0.109	0.236***	0.004	0.036	0.046	0.036	0.060	0.404***			1.39
GOV	0.130*	0.060	0.492***	0.498***	0.523***	0.521***	0.192**	-0.120	0.102		1.20
FOR	0.363***	0.470***	0.215***	0.003	0.027	0.038	0.183**	0.244***	0.140*	-0.053	1.12

All variables are as explained in Table 3. [a] VIF: is the variance inflation factor. VIF values are calculated by including return on assets from the financial performance indicators as the dependent variable as well as all other independent variables of the basic regression model. In other words, Model 10 is used when calculating the VIF values. VIF values are also the same as the results in the table in the regression models formed by using the return on equity (ROE) and return on sales (ROS). When R&D variables (RD_t, RD_{t-1}, and RD_{t-2}) are included in the regression models separately, the greatest VIF value is 1.67. ***, **, * represents statistical significance at 1, 5 and 10% level respectively.

Table 4 also shows that there is a positive relationship between R&D variables and financial performance indicators. However, this relationship is statistically significant for ROA and ROS but insignificant for ROE. There is a positive relationship between LNTA and EXPSA, and financial performance indicators as well, and this relationship is statistically significant for only ROE. There is a statistically significant negative relationship between the LEV variable and ROA and ROS; however, there is a statistically significant positive relationship between LEV and ROE. The relationship between public ownership share (GOV) and financial performance indicators is also positive, and this relationship is statistically significant for ROA and ROS. There is a statistically significant positive relationship between foreign ownership shares (FOR) and all financial performance indicators.

5.2. Regression Results

The results related to the twelve models showing the relationship between the financial performances of the sub-sectors constituted by the largest 500 firms of Turkey and R&D intensity presented in Table 5. Model (1, 2, and 3) show the effect of current year R&D intensity, Model (4, 5, and 6) show the effect of one year lagged R&D intensity, Model (7, 8, and 9) show the effect of two years lagged R&D intensity, and Model (10, 11, and 12) show the effect of all R&D variables on return on assets (ROA), return on equity (ROE), and return on sales (ROS). In other words, the test results presented in Table 5 related to the research hypothesis. The F-statistic results related to the regressions show that all models presumed in the study are statistically significant. Hausman test results point out that a fixed effects estimator should be used in all models. In this context, all models are estimated by the one-way fixed effects model. Therefore, there is no time effect in the models. When the explanatory power of models compared, it is seen that the model that represents ROA the best is Model (1), the model that represents ROE the best is Model (2), and the model that represents ROS the best is Model (12). Accordingly, it is seen that lagged R&D intensity variables are more successful in explaining financial performance indicators in parallel with the literature.

The results of Model (1, 2, and 3) in Table 5 show that current year R&D intensity has a statistically significant negative effect on financial performance indicators (ROA, ROE, and ROS) at a 1% significance level in the 2013-2019 period (β = -0.445, -0.706, and -1.305 respectively). This finding is compatible with recommendations of studies conducted in Turkey (Kiracı & Arsoy, 2014; Polat & Elmas, 2016; Güzen & Başar, 2019) and developed and developing countries (Shin et al., 2017; Chen et al., 2019; Liu et al., 2019; Alam et al., 2020) indicating that there is a negative relationship between current year R&D spending and firm performance. Additionally, coefficients of the RD_t variable are negative in the results of Model (10, 11, and 12) and this is statistically significant (β = -0.770, -1.782, and -2.573 respectively). All these findings strongly support the first hypothesis of the research, suggesting that current year industry financial performances will be affected negatively as current year industry R&D spending increases.

R&D spending is long-term and for their effect on financial performances of the sectors to occur taking a certain amount of time, shape the expectation that current year R&D spending might have a positive effect on financial performance indicators in the upcoming years. As expected, the results of Model (4, 5, and 6) show that one-year lagged R&D spending (RD_{t-1}) has a positive effect on the financial performances of the sectors (β = 0.482, 0.546, and 3.508 respectively). On the other hand, coefficients of the RD_{t-1} variable are negative in Model (10 and 11), where ROA and ROE are used as financial performance indicators, and it is statistically insignificant for Model 10 (β = -0.086). However, the result is positive in Model (12), where ROS is used, and this is statistically significant at a 1% significance level (β = 1.816). These results obtained from the regressions support a good number of studies in the literature conducted for the firms (Zhu & Huang, 2012; Alper & Aydoğan, 2016; Dağlı & Ergün, 2017; Chen et al., 2019; Zang et al., 2019). On that note, it is found that one-year lagged R&D spending in the industrial sector has a positive effect on the current year's industry financial performance; thus, the second hypothesis of the research is partially accepted. However, contrary to expectations, the results of Model (7, 8, and 9) demonstrate that two-year lagged R&D spending (RD_{t-2}) has a statistically significant negative effect at a 1% significance level on ROA, ROE, and ROS (β = -0.182, -0.486, and –0.139 respectively). These findings related to the RD_{t-2} variable are also supported by the coefficients regarding this variable obtained from Model (10, 11, and 12) (β = -0.809, -2.016, and -1.986 respectively). For that reason, the third hypothesis of the research rejected due to the findings that two-year lagged R&D spending negative effect on the current year's financial performance indicators of the industrial sector. This result contradicts the findings of studies (Shin et al., 2017; Chen et al., 2019; Güzen & Başar, 2019; Liu et al., 2019) asserting that R&D spending increases the profitability of the firms in the long term.

Table 5: The Effect of R&D Spending on Financial Performance

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
Dependent Variable	ROA	ROE	ROS	ROA	ROE	ROS	ROA	ROE	ROS	ROA	ROE	ROS
RD_t	-0.445***	-0.706***	-1.305***							-0.770***	-1.782***	-2.573***
	(0.066)	(0.190)	(0.115)							(0.073)	(0.313)	(0.103)
RD_{t-1}				0.482***	0.546**	3.508***				-0.086	-0.871*	1.816***
				(0.133)	(0.242)	(0.121)				(0.154)	(0.493)	(0.124)
RD_{t-2}							-0.182***	-0.486***	-0.139*	-0.809***	-2.016***	-1.986***
							(0.051)	(0.131)	(0.068)	(0.100)	(0.439)	(0.151)
LNTA	0.021*	0.058	0.039***	0.016	0.034	0.030**	0.019	0.017	0.029*	0.019	0.015	0.031**
	(0.011)	(0.036)	(0.013)	(0.011)	(0.041)	(0.012)	(0.016)	(0.074)	(0.015)	(0.016)	(0.075)	(0.015)
LEV	-0.098	0.004	-0.101	-0.067	0.056	-0.081	-0.065	0.058	-0.100	-0.066	0.053	-0.093
	(0.072)	(0.187)	(0.097)	(0.061)	(0.174)	(0.069)	(0.060)	(0.191)	(0.072)	(0.061)	(0.196)	(0.072)
EXPSA	-0.037	-0.173	-0.142*	-0,018	-0.113	-0.094	-0.010	-0.075	-0.095	-0.008	-0.073	-0.083
	(0.048)	(0.157)	(0.081)	(0.037)	(0.116)	(0.061)	(0.033)	(0.118)	(0.061)	(0.032)	(0.116)	(0.057)
GOV	0.053	0.126	0.231**	-0.003	-0.068	0.127	0.058	-0.175	-0.217	0.043	-0.214	0.175**
	(0.063)	(0.241)	(0.111)	(0.038)	(0.146)	(0.100)	(0.091)	(0.386)	(0.189)	(0.077)	(0.392)	(0.076)
FOR	-0.071	-0.257	-0.028	-0.082	-0.302	-0.049	-0.067	-0.396	-0.039	-0.073	-0.407	-0.060
	(0.075)	(0.303)	(0.084)	(0.069)	(0.347)	(0.061)	(0.098)	(0.546)	(0.080)	(0.100)	(0.553)	(0.084)
Constant	-0.333	-1.087	-0.715***	-0.249	-0.566	-0.568**	-0.324	-0.142	-0.503	-0.307	-0.073	-0.535
	(0.212)	(0.809)	(0.262)	(0.232)	(0.988)	(0.257)	(0.371)	(1.820)	(0.349)	(0.375)	(1.848)	(0.342)
Time Effect	No	No	No	No	No	No	No	No	No	No	No	No
Obs. (sectors)	173 (25)	173 (25)	173 (25)	148 (25)	148 (25)	148 (25)	123 (25)	123 (25)	123 (25)	123 (25)	123 (25)	123 (25)
F Test[a]	7.42***	4.98***	8.41***	7.35***	4.27***	6.70***	6.02***	3.23***	5.05***	6.13***	3.23***	6.59***
BP LM Test[b]	66.46***	30.03***	37.86***	66.24***	23.31***	55.61***	43.39***	11.29***	17.32***	44.06***	11.26***	29.94***
Hausman Test[c]	25.20***	24.09***	39.83***	16.85**	17.23***	18.44***	13.35**	13.66**	33.75***	21.79***	15.89**	25.54***
F-statistic[d]	38.85***	10.12***	13.40***	5.84***	5.39***	249.65***	7.61***	4.85***	2.11*	29.55***	19.98***	640.43***
R^2	0.13	0.07	0.19	0.09	0.04	0.28	0.08	0.03	0.10	0.11	0.05	0.40

The heteroscedasticity and autocorrelation robust standard errors are in the parentheses. [a] For significance values 5% and under, the H0 hypothesis claiming that the unit effects are equal to zero is rejected, and therefore it is concluded that the classical model is not applicable. [b] For significance values 5% and under, the H0 hypothesis claiming that the variance of the unit effects is equal to zero is rejected, and therefore it is concluded that the classical model is not applicable. [c] For significance values 5% and under, the H0 hypothesis claiming that random-effects model is suitable is rejected, and therefore it is concluded that the fixed effects model is applicable. [d] For significance values, 5% and under, the model as a whole is decided to be significant. ***, **, * represents statistical significance at 1, 5 and 10% level respectively.

Finally, empirical findings related to the control variables of all of the models presented in Table 5 demonstrate that the size of the sector (LNTA) statistically significant positive effect on financial performance indicators in several models. This finding is compatible with the findings of other studies in the literature (Bae et al., 2008; Ayaydın & Karaaslan, 2014;

Chen et al., 2019; Liu et al., 2019; Xu et al., 2019; Alam et al., 2020) and it suggests that larger sectors tend to gain even more. Coefficients related to other control variables in all models are statistically insignificant except export rate (EXPSA) and public ownership share (GOV) in Model (3 and 12). Although the EXPSA negatively affects the ROS in Model (3), the GOV affects it positively. The GOV positively affects the ROS in the Model (12) too. On the other hand, the leverage ratio (LEV) and the foreign ownership share (FOR) do not have any statistically significant effect on the financial performances of industrial sub-sectors.

5.3. Robustness Test

In several studies, the ratio of R&D expenditures to net sales (RD) and R&D expenditures to total assets (RDTA) used as a proxy of R&D intensity. Besides, these R&D variables are used interchangeably for a robustness test (Block, 2012; Vithessonthi & Racela, 2016). Therefore, the robustness of the findings tested using the RDTA variable instead of the RD variable in Equation (1). Table 6 presents the robustness test results of the models (Models 13, 14, and 15) that shown the effects of $RDTA_t$ and its lagged values ($RDTA_{t-1}$, $RDTA_{t-2}$) on financial performance (ROA, ROE, and ROS). In general, the findings obtained with an alternative measure of R&D spending (RDTA) are consistent with the main results of the study.

Table 6: Robustness Check

	Model 13	**Model 14**	**Model 15**
Dependent Variable	**ROA**	**ROE**	**ROS**
$RDTA_t$	-1.438*** (0.317)	-3.343*** (0.905)	-6.132*** (0.462)
$RDTA_{t-1}$	0.660 (0.861)	-0.993 (2.288)	5.439*** (0.691)
$RDTA_{t-2}$	-1.938** (0.793)	-6.294** (2.271)	-4.859*** (0.907)
LNTA	0.018 (0.016)	0.008 (0.078)	0.030* (0.015)
LEV	-0.063 (0.060)	0.058 (0.194)	-0.083 (0.074)
EXPSA	-0.008 (0.032)	-0.076 (0.107)	-0.080 (0.057)
GOV	0.049 (0.076)	-0.187 (0.378)	0.164** (0.073)
FOR	-0.077 (0.102)	-0.423 (0.559)	-0.072 (0.087)
Constant	-0.280 (0.396)	0.104 (1.936)	-0.508 (0.346)
Time Effect	No	No	No
Obs. (sectors)	123 (25)	123 (25)	123 (25)
F Test[a]	5.89***	3.23***	8.68***
BP LM Test[b]	41.66***	11.10***	45.06***
Hausman Test[c]	18.49**	15.14**	30.29***
F-statistic[d]	4.82***	8.80***	146.28***
R^2	0.11	0.05	0.38

The heteroscedasticity and autocorrelation robust standard errors are in the parentheses. [a] For significance values 5% and under, the H0 hypothesis claiming that the unit effects are equal to zero is rejected, and therefore it is concluded that the classical model is not applicable. [b] For significance values 5% and under, the H0 hypothesis claiming that the variance of the unit effects is equal to zero is rejected, and therefore it is concluded that the classical model is not applicable. [c] For significance values 5% and under, the H0 hypothesis claiming that random-effects model is suitable is rejected, and therefore it is concluded that the fixed effects model is applicable. [d] For significance values, 5% and under, the model as a whole is decided to be significant. ***, **, * represents statistical significance at 1, 5 and 10% level respectively.

6. Conclusion and Discussion

The relationship between R&D spending and financial performance indicators has been discussed in many studies. When the literature reviewed, it is possible to come across studies arguing that R&D spending has a positive, negative effect or has no effect on the financial performances of the firms. In this study, R&D intensities of twenty-five industrial sub-sectors constituted by the largest 500 firms of Turkey in the 2013-2019 period are calculated, and how R&D intensity (RD) affects the financial performances of the sectors is explored with panel data analysis. The study contributes a great deal to the literature by examining the effect of sectoral level R&D intensity on financial performance (ROA, ROE, and ROS). It is seen that many studies conducted in Turkey (Ayaydın & Karaaslan, 2014; Alper & Aydoğan, 2016; Polat & Elmas, 2016; Dağlı & Ergün, 2017) and around the world (Bae et al., 2008; Chen et al., 2019; Liu et al., 2019; Alam et al., 2020) focus more on firms and do not investigate such an effect at a sectoral level from a different point of view. Furthermore, many studies conducted in recent years suggest that the effects of R&D spending occurs after a year or more, and for that reason, argue that R&D spending has a lagged effect on financial performance (Lee & Choi, 2015; Güzen & Başar, 2019; Liu et al., 2019; Zang et al., 2019). In this context, both the current year and lagged year's R&D intensity are included in the study to clarify the relationship between R&D spending and financial performance in more detail. In other words, by analysing the R&D spending of the industrial sub-sectors constituted by the largest 500 firms of Turkey, this study shows that the firms in these sectors should concentrate on the key impact of both current and lagged year R&D spending on financial performance.

The findings of the study demonstrate that the industrial sector constituted by the largest 500 firms of Turkey has a fairly low R&D intensity (0.6%) in the 2013-2019 period. When means of lagged years R&D intensity is considered (0.6%), it is seen that the industrial sector could not really increase the R&D spending in recent years, and therefore, adequate importance is not placed on R&D spending supporting economic and financial performance. Liu et al. (2019) state that only values of R&D intensity over 4% might lead to high economic growth and increased financial performance. In the analysed period, the mining and quarrying sub-sector has the highest average R&D intensity with 5.58%. Considering that the world's pioneering firms have an R&D intensity of around 5-6% level (Polat & Elmas, 2016), it can be argued that only the mining and quarrying sub-sector gave sufficient weight to R&D spending in recent years within the industrial sector.

The regression results show that current year R&D intensity affects the financial performance of industrial sub-sectors negatively. This result supports the consensus in the literature (Lee & Choi, 2015; Chen et al., 2019; Güzen & Başar, 2019; Liu et al., 2019; Alam et al., 2020) that current year R&D spending reduces the current year earnings within the income statement by increasing the operating expenses, and output growth, cost reduction, and competitive advantage effects of these expenditures occur in the long term. In this regard, the regression results demonstrate that the R&D spending made within the industrial sector has a one-year lagged positive effect on financial performance. However, conflicting with the literature (Chen et al., 2019; Güzen & Başar, 2019; Liu et al., 2019), this positive effect on financial performance cannot be sustained, and it can be seen that two-year lagged R&D spending has a negative effect on industry financial performance. To put it another way, two-year R&D spending has a reducing effect on the current year's financial performance. Altınbay et al. (2017) declare that R&D spending made by firms in the BIST Sustainability Index creates positive effects in the short term, but this effect either disappears or turns negative in the long term.

Several explanations and suggestions can be offered for these results obtained in the study. First of all, as it can be seen from the averages of R&D intensities, the failure to make consistently increasing R&D spending and focusing mostly on short-term profit targets with R&D spending made in the sector might have turned the long-term positive effect of R&D spending on financial performance to negative. Polat & Elmas (2016) indicate that a great number of firms in Turkey still do not make regular R&D spending, and those R&D spending that has been made are also not used efficiently. Wang (2011) states that there is a threshold level for R&D spending, and R&D spending under this threshold might have a negative effect on financial performance. Keeping these remarks in mind, it can be claimed that the industrial sector should make R&D intensive investments to adapt to today's technological advances faster and to increase its financial performance. Secondly, there are very few big high technology firms with high R&D intensity in the industrial sector. Thirdly, the industrial sector might not be employed a qualified labour force to conduct and maintain R&D spending efficiently in the long term. In this context, as Chen & Wu (2020) also state, employing a qualified labour force, and as well as ensuring its persistence and its continuing education is another issue to take note of. Fourthly, it can be claimed that the public sector is not adequately leading the industrial sector regarding R&D spending. In the analysed industrial sector, public shares are at around the level of 3%. Industrial sub-sectors with high public ownership share focusing on R&D spending, and thereby financial performances of these sectors getting much better can serve as an example for other sub-sectors. Furthermore, in many studies, it is possible to come across findings indicating that R&D spending subsidies at a certain level might encourage innovative activities and finally make financial performance better (Liu et al., 2019; Liu et al., 2019). Fifthly, similar to Ehie & Olibe (2010) pointing out the effects of the 9/11 attacks on the manufacturing sector; the economic, social, and political events happening in Turkey in recent years (such as Gezi Park protests, the July 15 coup attempt, the Syrian civil war, relations with the EU, and elections, etc.) might have negatively affected R&D activities of the industrial sector. Lastly, differently from the literature, these findings were obtained at the sectoral level. As Altınbay et al. (2017) and Polat & Elmas (2016) also indicate, R&D spending at the firm level might create a positive effect on the financial performances of some firms operating within the industrial sector in the long term.

Some of the limitations of this study might provide insight for further research. Firstly, the period of analysis of this study is a relatively short period of time. The shortness of the analysed period might have affected the lagged R&D spending results in the research. Secondly, various variables such as the number of R&D personnel working in the sectors, the expenses made for this personnel, and subsidies for R&D spending can be added to econometric models. Besides, whether there is a non-linear relationship between R&D spending and financial performance might be investigated with different econometric models. Thirdly, the study cannot present a firm-level point of view due to R&D spending data being published at the sectoral level. So, generalizations for firms from the findings of the study should be made carefully. In addition to this, by obtaining the R&D expenditures of the largest 500 industrial firms, more accurate interpretations might be made with a detailed analysis.

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