REFLECTION OF R&D SPENDING ON FINANCIAL PERFORMANCE: CASE OF AVIATION SECTOR

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Abstract

The aim of this study is to investigate the affect of R&D spending in the Turkish aviation sector on the financial performance of the sector. Three research models were established in the study covering the 2008-2021 period and analyzing annual sector data. The models use dependent variables; return on assets (ROA), return on equity (ROE) and return on sales (ROS), and independent variable; R&D intensity and control variables; financial leverage ratio, liquidity ratio and sector size. 14-year data of the aviation industry were analyzed with multiple linear regression analysis. As a result of the analysis, the R&D spending in the aviation sector had a statistically significant and positive affect on the financial performance of the sector. On the other hand, financial leverage ratio which were the control variables in the model, had a negative affect on the ROS of the aviation sector, while the liquidity ratio and the size of the sector had a positive affect on the financial performance.

Keywords: Aviation Sector, Financial Performance, R&D Spending, Multi-Linear Regression Analysis

JEL Codes: C58, L25, O32

AR-GE HARCAMALARININ FİNANSAL PERFORMANSA YANSIMASI: HAVACILIK SEKTÖRÜ ÖRNEĞİ

Öz

Bu çalışmanın amacı, Türkiye havacılık sektöründe yapılan Ar-Ge harcamalarının, sektörün finansal performansı üzerindeki etkisini araştırmaktır. 2008-2021 dönem aralığını kapsayan ve yıllık sektör verilerinin analiz edildiği çalışmada üç araştırma modeli kurulmuştur. Modellerde bağımlı değişkenler; aktiflerin kârlılığı, özsermaye kârlılığı ve satışların kârlılığı, bağımsız değişken; Ar-Ge yoğunluğu, kontrol değişkenleri ise finansal kaldıraç oranı, likidite oranı ve sektör büyüklüğü kullanılmıştır. Havacılık sektörüne ait 14 yıllık veriler, çoklu doğrusal regresyon analizi ile incelenmiştir. Analiz sonucunda, havacılık sektöründe yapılan Ar-Ge harcamalarının, sektörün finansal performansı üzerinde istatistiksel olarak anlamlı ve pozitif yönlü etkisi belirlenmiştir. Öte yandan, havacılık sektörünün finansal performansı üzerinde kontrol değişkeni olarak kullanılan likidite oranı ve sektör büyüklüğü pozitif yönlü etkiye sahipken, finansal kaldıraç oranı ise satışların kârlılığı üzerinde negatif yönlü etkiye sahiptir.

Anahtar Kelimeler: Havacılık Sektörü, Finansal Performans, Ar-Ge Harcamaları, Çoklu Doğrusal Regresyon Analizi

JEL Kodları: C58, L25, O32

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INTRODUCTION

In the globalizing world of the 21st century, the dizzying technological developments in many sectors and fields bring about changes in the needs and expectations of individuals and companies. Undoubtedly, one of the most substantial ways for companies to get ahead of their competitors and gain an advantage in market share in the increasing competitive conditions is to focus on innovative activities by keeping up with technological change and transformation. Companies that have desire to grow rapidly and be sustainable in today's business world, where competition is intense, are required to strategically consider Research and Development (R&D) activities and the spending to be made in order to be innovative.

The research direction of R&D, consisting of a combination of research and development concepts, includes activities aimed at new information and findings, while the development direction focuses on elements such as materials, systems, processes necessary for a better and higher quality product (Freihat and Kanakriyah, 2017, p. 74). In accordance with the article 3 of the Law No. 4691 on Technology Development Zones, R&D is defined as "to obtain new information that will enable the development of science and technology, or to produce new materials, products and tools with existing information, to create new systems, processes and services, including software production, or it is defined as "regular studies with the aim of improving existing ones" (Bezirci, 2012, p. 10). Although different definitions are made for R&D, the definition put forward by the OECD in general is taken into account in the field. Accordingly, R&D is expressed as "knowledge, including knowledge of people, culture and society, and the use of this knowledge to design new applications" (Lee, Sooyoung, and Lee, 2011, p. 78). The spending made within the scope of R&D include three different applications as basic research, experimental development and applied research (Tung and Binh, 2021, p. 2). Although it is difficult to distinguish between basic research and applied research, empirical studies are generally divided into two components: research and development. While research activities are abstract, complex and uncertain, development activities are more practical and oriented to comply with the demand of the customer and the market (Dai, Guo, and Wang, 2020, p. 740).

R&D provides a strong competitive advantage especially for companies operating in sectors where high technology usage is intense (Chang, Chiu, and Wu, 2017, p. 136; Neves and Branco, 2020, p. 287). The aviation industry, which is one of these sectors and is included in the transportation sector, attracts the attention of researchers in the field of industrial and finance with many changes that have reshaped itself in recent years (Malighetti, Meoli, Paleari, and Redondi, 2011, p. 359). On the other hand, with urbanization, high population growth and industrialization, air transportation has an important place in the growth targets of a country and region (Hu, Xiao, Deng, Xiao, and Wang, 2015, p. 95). Within the scope of this information,

no study investigating the relationship between R&D spending and company performance in the context of the aviation sector has been found in the literature review. This determination and the timeliness of the study express the original aspect of the research. In this direction, the relationship between financial performance and R&D spending is discussed in the first part of the study. In the second part, information about the aviation sector is presented. In the third part, literature review, in the fourth part, the applications and findings, and in the fifth part, the conclusion is stated, respectively.

FINANCIAL PERFORMANCE AND R&D SPENDING RELATIONSHIP

In addition to being an important factor of competitiveness, R&D is among the main determinants of firm performance and value (Chang et al., 2017, p. 136). Traditional and modern financial performance measurement techniques are used to measure financial performance. While traditional measurements are based on accounting, modern measurements are value-based. Namely, traditional measurements are based on measures such as whether the planned budgets are reached in the company, whether the employees have done the desired, and whether the production and sales goals have been achieved. On the other hand, modern measurements take market performance into account. However, financial ratios are used more intensively due to the convenience it provides in terms of interpretation and comparability (Yakıcı-Ayan and Değirmenci, 2020, p. 21). In the field article, more profitability ratios of companies have been taken into account as an indicator of financial perfomance. Ratios such as the return on assets of companies, return on equity and profitability of sales are among the most frequently used indicators for financial performance (Ravšelj and Aristovnik, 2020, p. 5). The profitability indicator is expressed as a determinant of financial autonomy (Neves and Branco, 2020, p. 288).

Regarding the studies examining the relationship between R&D investments and financial performance, there are studies that indicate R&D spending affect financial performance of companies positively, as well as studies that show that they affect them negatively (Hazarika, 2021, p. 2). As an example of this situation, Rzakhanov (2004); Pindado, De Queiroz, and Torre (2010); VanderPal (2015); Freihat and Kanakriyah (2017); Dai et al., (2020) determined a statistically positive relationship between firm performance and R&D spending in their study, while Schoeffler (1977); Cazavan-Jeny and Jeanjean, (2006); Neves and Branco (2020) found a negative relationship between financial performance and R&D spending in their study. On the other hand, in some studies, the authors suggested that R&D spending would affect firm profitability with a lag (Falk, 2012; Rao, Yu and Cao, 2013; Huang, Wu, and Tsai, 2016).

AVIATION SECTOR IN THE WORLD AND IN TURKEY

Although the aviation sector is among the newest and most recently developing sectors in the world in a historical sense, it is one of the few strategic sectors with a very high scientific and technological composition, rapid structural changes, and where the security element is at the forefront. In this regard, it shows a rapid improvement in both in civilian and military fields, has a high global scale and competitive conditions, and enters the priority areas of especially developed countries as a strategic sector (İşler, Demir, and Üstün, 2012, p. 5). Considering the outlook of the aviation sector in the world, the rapid growth trend of China and India in the inductry draws attention. Emerging market economies such as China attach importance to the service-based economy, which supports the demand for continuous air travel for the future (Macit and Macit, 2017, p. 76). The aviation sector, where technological developments are primarily implemented, plays an important role in both international and intercontinental harmony and integration. The development of air transportation contributes to the expansion of international trade, faster and easier travel of people and progress of tourism. In this context, economic value of the aviation sector, which ensures the transportation of passengers and high value-added products as quickly as possible, is constantly increasing and plays a leading role in the development of both countries and other sectors (DHMİ, 2019, p. 11).

It can be said that the aviation sector has been greatly affected by crises in terms of its structure. At the moment of any crisis, consumers first tend to abandon travel (especially the airline) and turn to basic needs. In the past years, there have been periods of contraction and stagnation in the aviation industry due to crises such as the Gulf Wars, 2008 Global Financial Crisis, SARS, and MERS. However, none of these crises brought civil air traffic to a standstill like Covid-19 pandemic (Akça, 2020, p. 46). With the gradual lifting of travel restrictions imposed by countries due to Covid-19, a recovery has been observed in the aviation sector. In respect of the data published by the International Aviation Organization (ICAO), international passenger traffic amounted to 2.3 billion in 2021. While this figure decreased by 49% in 2021, there was a 60% decline in passenger traffic in 2020 compared to 2019. In particular, from a financial point of view, after a financial loss of $ 372 billion in 2020, a financial loss of $ 324 billion occurred in 2021 (SHGM, 2021a, p. 26). Currently, ICAO predicts that total passenger traffic in 2022 will be between 26% and 31% lower than pre-Covid-19 levels (DHMİ, 2021, p. 10). According to the global market forecasts of Airbus, one of the largest firms in the world aviation industry, 37400 new aircraft will be required by 2037. The economic size of this demand is worth $ 5.8 trillion. Airline companies that take into account the growth in the aviation industry and regulate their technological infrastructure accordingly will be able to increase their profitability and market share with new products offered (Soyal, 2019, p. 22).

The rapidly growing sector, infrastructure and fleet investments, the number of connections and the regulations on air ticket prices, turnover and employment were also reflected in the number of airline companies operating in the aviation sector after the structural arrangements made in Turkey since 2003. The number of personnel, turnover and R&D spending related to the aviation sector in Turkey are Dec in Table 1. while about 65 thousand employees were employed in the sector in 2003, this number increased more than 3 times to 245,876 in 2020. In terms of sector turnover, it has increased from ₺ 3 billion to 105.68 billion since 2003. On the other hand, the Dec allocated to R&D within the scope of operating spending in the Turkish aviation sector was ₺ 5.24 million in 2017, and this amount increased to ₺ 11.62 million in 2020. In other words, in the four-year period between 2017 and 2020, the R&D spending in the aviation industry has more than doubled.

Table 1: The number of personnel, turnover and R&D spending related to the aviation sector

Years	Number of Personnel	Turnover (Billion ₺)	R&D Spending (Million ₺)
2020	245,876	105,68	11,62
2019	295,547	160,71	8,51
2018	209,040	143,32	6,58
2017	196,041	91,63	5,24
2003	65,000	3,06	-

Source: Created by the author from the data obtained from SHGM.

LITERATURE REVIEW

In the literature, it is seen that studies investigating the relationship between financial performance and R&D spending of companies are generally conducted in different sectors and fields. However, the limited number of studies investigating the relationship between financial performance and R&D spending in the aviation sector shows the originality of this study. In this context, Jomo, Oloko, and Orwa (2017) examined the relationship between innovation and financial performance in the aviation industry in Kenya. The authors determined a statistically positive and significant relationship between innovation and profitability in the aviation industry in the results of probit regression and correlation analysis.

Surkova and Mazhaiskii (2021) investigated the determinants of financial performance in the aviation industry. As a result of the study, the authors determined that profitability and innovation factors were determinative on financial performance. Hidalgo and Palomares (2022) proposed a model for innovation in

the aviation industry. The authors designed the 5F3D model based on the analysis of different innovation models. In particular, they established five organizational factors and three determinants in the evaluation of innovation management in the aviation industry. In line with the study, the authors drew attention to the importance of innovation in the aviation industry.

Signficance of innovative activities was also emphasized in some other studies investigating the impact of innovation in the aviation industry (Burg et al., 2014; Angayarkanni and Raja, 2015; Khosropour et al., 2015; Armatlı-Koroglu and Ozelci-Eceral, 2015; Amankwah-Amoah, 2021). In the study conducted by Sumerli-Sarıgül and Coşkun (2022), it was determined that the innovative activities implemented in the aviation sector would have a positive effect on financial performance and may provide profit maximization advantage in the long run.

Various studies investigating the relationship between the aviation industry and financial performance are also available in the literature. Chin and Tay (2001) examined the relationship between the growth of the Asian aviation industry and profitability and investment. Through using the regression analysis, the authors determined a positive relationship between the growth of the aviation industry and profitability as a result of the study. Muramalla and Altamimi (2014) examined the financial performance of the aviation industry in their study. The authors drew attention to the importance of innovative activities in order to reduce the costs of airline companies and increase their efficiency. Huang (2021), on the other hand, examined the financial performance of 22 airline companies operating in the aviation sector in the Asia-Pacific region for the periods between 2016-2019. As a result of the study, the author proposed to manage the capital structures of airline companies and increase their financial stability.

Looking at the studies examining the relationship between financial performance and R&D spendings, for instance, Lee et al. (2011) investigated the affect of R&D on the performance of small and medium-sized companies operating in the information and communication sector in Korea. The data obtained by conducting a survey on a sample of 100 companies were analyzed by structural equation modeling. The authors determined a positive relationship between the financial performance of companies and R&D. Li and Hwang (2011) investigated the affects of firm size, R&D spending, financial leverage on company profitability. The authors analyzed the data of S&P 500 companies for the periods 1996 to 2005 using the least squares method. The authors determined that R&D spending would affect the profitability of the company in a statistically significant and positive way.

Sharma (2012) investigated the impact of R&D activities on the productivity of company operating in the pharmaceutical industry in India. The author analyzed the data of 89 companies for the period 1994-

2006 using the least squares method. The author revealed a statistically significant and positively relationship between R&D intensity and productivity.

Rao et al. (2013) investigated the affect of R&D investments on the performance of companies in technology-intensive industries in China and Japan. As a result of the study, in which the periods between 2007 and 2011 were investigated by regression analysis, the authors determined that R&D investments affected firm performance with a lag.

Apergis and Sorros (2014) investigated the relationship between the profitability of companies operating in the energy sector and their R&D spending. The authors analyzed the data for the periods between 1990 and 2011 by using panel data analysis method. As a result of the study, in which variables such as return on assets, return on equity and cash flow were used as profitability indicators, the authors concluded that R&D spending statistically affected the profitability of the company in a positive way.

VanderPal (2015) examined the affect of R&D spending on the financial performance of companies by using the data of 103 firms in S&P for the period between 1979 and 2013. The author determined a positive relationship between firm performance and R&D spending through panel data analysis.

Huang et al. (2016) investigated the affect of R&D spending on the financial performance of high-tech companies in Taiwan. The authors analyzed the data of the companies for the periods between 1988 and 2011 with VAR. The authors determined that R&D spending would have a statistically positive affect on the financial performance of companies in the long run.

Freihat and Kanakriyah (2017) investigated the role of R&D spending on the financial performance of companies operating in the pharmaceutical industry in Jordan. In the study, the authors tested firm data for the period 2006-2015 using regression and correlation analysis. The authors revealed a statistically positively relationship between the financial performance of the companies and their R&D spending.

Ravšelj and Aristovnik (2020) investigated the affect of R&D spending on the performance of companies in the sample of USA, Europe, China and Japan. The authors searched for data from 2012-2016 using multiple regression analysis. The authors argued that R&D spending did not have an affect on company performance in the short run, but might provide a certain benefit in the long run.

Leung and Sharma (2021) investigated the affect of R&D intensity on the performance of companies traded in Shanghai and Shenzhen stock exchanges. The authors analyzed annual data from 2010-2013 using

panel data analysis. The authors determined that the R&D intensity had a negatively affect on company performance in the short term and a positive affect in the long term.

Pham, Nguyen, and Hoang (2021) investigated the role of R&D spending on the profitability of companies operating in the textile industry in Vietnam. The authors tested the data of the companies for the periods between 2010-2020 with panel data analysis. The authors determined a positively relationship between R&D spending and firm profitability.

Tung and Binh (2021) investigated the affect of R&D investments on the financial performance of companies operating in Vietnam. The authors analyzed the period from 2010 to 2018 using the least squares method. As a result of the analysis, the authors determined a positive relationship between the profitability of companies and their R&D investments.

There were also studies that found a statistically negative relationship between the financial performance and R&D spending of companies. For instance, Neves and Branco (2020) investigated the possible determinants of R&D investments using panel data analysis, using data from 155 high-tech companies in a sample of European countries. Utilizing annual data for the period between 2010 and 2016, the authors found a statistically negative relationship between R&D investments, profitability and fixed assets. A similar result was revealed in the study by Hazarika (2021). Hazarika (2021) investigated the relationship between R&D spending and firm profitability in the context of the alternative energy sector. The author analyzed the 10-year data of 24 alternative energy companies between 2007 and 2016 using panel data analysis. The author found a negative affect of R&D spending on active profitability, while he did not find any affect on defiency of equity.

Concerning the national literature examining the relationship between the financial performance and R&D spending of companies, Dağlı and Ergün (2017) investigated the relationship between the financial performance of firms operating in Borsa Istanbul manufacturing sector and their R&D spending. The authors analyzed the financial data for the periods between 2010 and 2013 using the panel least squares method. The authors revealed a statistically significant and positive relationship between financial performance and R&D spending. Kılıç (2020) investigated the role of R&D spending on the financial performance of companies in Borsa Istanbul IT sector. The author tested company data for the periods between 2012 and 2018 with panel data analysis. As a result of the study, the author found a statistically positive and significant relationship between R&D intensity and financial performance. Dikici and Gürdal (2021) investigated the causal relationship between R&D spending, profitability and growth. The authors analyzed firm data between 2005 and 2019 with a causality test. The authors determined a causality from R&D intensity to

firm profitability indicators. Özkan (2022) investigated the relationship between financial performance and R&D spending within the scope of Turkey's largest 500 industrial companies. With respect to the study, in which panel data analysis was used, the author concluded that R&D spending affected financial performance positively with a lag, but this affect turned negative in the long run.

When the studies in the literature are investigated; the relationship between financial performance and R&D spending was examined by using the data of companies operating in different sectors, and some studies found a statistically positive relationship, while others found a negative relationship. Considering the sectors studied, the lack of research on the aviation sector, whose importance and use in transportation has become increasingly widespread in recent years, could be expressed as the motivation of the study.

EMPIRICAL ANALYSIS

Dataset and Variables

In this study, the annual sectoral financial statements of the companies operating in the Turkish aviation sector between the years 2008-2021 were used. The data of the study investigating the relationship between the financial performance of the aviation industry and R&D spending were obtained from the industry financial statements published by the General Directorate of State Airports Authority (DHMI).

Dependent variables

Three dependent variables trying to determine financial performance were used in the research model. In determining the financial performance of the aviation sector, accounting-based performance indicators were taken into account by making use of the studies in the literature. Return on assets (ROA) used as dependent variables (Hitt, Hoskisson, and Kim, 1997; Geringer, Tallman, and Olsen, 2000; Ravšelj and Aristovnik, 2020; Pham et al., 2021), return on equity (ROE) (Grant, 1987; Li and Hwang, 2011; Rao et al., 2013) and profitability of sales (ROS) (Geringer et al., 2000) were widely preferred as financial performance indicators in empirical studies in the literature. As a financial performance indicator, ROA is defined as the ratio of the annual net income of a company or sector to the annual total assets of the company or sector. In other words, it expresses the net return on total assets. ROE is defined as the ratio of a company's or industry's annual net income to its total equity. This variable is an effective financial performance indicator in terms of generating income from new investments. In other words, ROE shows how much return the money invested by the shareholders will provide (Freihat and Kanakriyah, 2017, s.76). The ROS variable, on the other hand, indicates the net income of the company or the sector from its sales. The main reason for choosing the three dependent variables used in the study is that the aviation industry illustrates whether

investment, equity and sales are used effectively. These indicators are namely strong indicators of financial performance in studies in the literature.

Independent variable

The main independent variable of the study is R&D intensity. R&D includes spending on developing a product or service or solving current or future problems. The use of the R&D variable in the literature is quite common. In this study, it was calculated as the ratio of the R&D spendings made by the aviation sector to the net sales (revenue) of the aviation sector while determining the R&D intensity. These calculation techniques were widely performed in the literature (Wang, 2011; Freihat and Kanakriyah, 2017; Erdoğan and Yamaltdinova, 2019).

Control variables

Empirical studies suggest that other financial factors may also be effective on financial performance. In the research model of this study, three control variables whose validity was tested have been applied. Aviation industry financial indicator leverage ratio was initially used. The financial leverage ratio, which expresses the ratio of total debt to total assets, requires more resources to repay high debt. It may negatively affect financial performance as this situation will reduce existing investments. The second control variable is the liquidity situation of the aviation industry. The liquidity ratio, which expresses the ratio of the sector's short-term current assets to the sector's total assets, will positively affect the financial performance of the sector as it reduces the risk of not being able to meet financial liabilities in the short term. Finally, the total asset size of the sector has been taken into account within the scope of the sector size indicator. An increase in this indicator may positively affect the financial performance of the sector (Ravselj and Aristovnik, 2020; 6).

Table 2: Summary of variables used in the empirical analysis

Abbreviation	Variable	Definition	Data Source	Variable's Type
ROA	Return on Assets	Net Profit/Total Assets	DHMİ (https://www.dhmi.gov.tr/)	Dependent
ROE	Return on Equity	Net Profit/Total Equity	DHMİ (https://www.dhmi.gov.tr/)	Dependent
ROS	Return on Sales	Net Profit/Net Sales	DHMİ (https://www.dhmi.gov.tr/)	Dependent
RDI	R&D Intensity	R&D Spendings/Net Sales	DHMİ (https://www.dhmi.gov.tr/)	Independent
LEV	Financial Leverage	Total Liabilities/Total Assets	DHMİ (https://www.dhmi.gov.tr/)	Control Variable
LIQ	Liquidity	Short-Term Assets/Total Assets	DHMİ (https://www.dhmi.gov.tr/)	Control Variable
LSIZE	Sector Size	The Natural Logarithm of Total Assets	DHMİ (https://www.dhmi.gov.tr/)	Control Variable

Source: Calculated and compiled by the author using financial table data.

Method

In the empirical study, multiple regression analysis method was used to determine the affect of R&D spending on financial performance. The regression model with more than one independent variable is called the multiple regression model. In other words, by examining the relationship of a dependent variable with another or several independent variables, it estimates the mean value of the population in terms of known or unchanged values in the repeated sample (Gujarati and Porter, 2009, p. 15). In this direction, the multiple regression model can be defined as follows (Gürünlü-Alma, 2013, p. 67).

$$y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \tag{1}$$

In the model in Equation 1, y is the dependent variable, β_0 is the constant term, β_1 and β_2 are the coefficients of the independent variables, X_1 and X_2 are the independent variables, and ε is the error term.

Analysis assumptions are supposed to be provided in order to obtain accurate and reliable results from regression analysis. These assumptions can be sorted as normal distribution, being zero of mean of error terms, linearity, constant variance, absence of autocorrelation problem and absence of multiple connections between independent variables (Albayrak, 2010: p. 259).

Research Model and Hypothesis

The model analyzed in the study by Ravšelj and Aristovnik (2020) was applied in the establishment of the research model.three basic research models have been established to investigate the affect of R&D spending in the Turkish aviation sector on financial performance. The economic forms of these models are as follows;

$$ROA = f(RDI, LEV, LIQ, SIZE) \tag{2}$$

$$ROE = f(RDI, LEV, LIQ, SIZE) \tag{3}$$

$$ROS = f(RDI, LEV, LIQ, SIZE) \tag{4}$$

The econometric forms of the models whose economic forms are presented above are as follows.

$$ROA_t = \beta_0 + \beta_1 RDI_t + \beta_2 LEV_t + \beta_3 LIQ_t + \beta_4 LSIZE_t + \varepsilon_t \tag{5}$$

$$ROE_t = \beta_0 + \beta_1 RDI_t + \beta_2 LEV_t + \beta_3 LIQ_t + \beta_4 LSIZE_t + \varepsilon_t \tag{6}$$

$$ROS_t = \beta_0 + \beta_1 RDI_t + \beta_2 LEV_t + \beta_3 LIQ_t + \beta_4 LSIZE_t + \varepsilon_t \tag{7}$$

In the research models, ROA, ROE and ROS were considered as dependent variables as the financial performance indicators of the aviation sector, while RDI was analyzed as independent variable. Finally, LEV, LIQ and LSIZE was used as a control variable. In addition, logarithmic transformation was applied to reduce the sharpness of the skewness and variation in variance of the variables in the model (Sarıdoğan and Kaya, 2019, p. 926).

The hypotheses developed using the literature in the study are as follows.

H_1: R&D spendings have a positive effect on the profitability of the aviation industry.

H_2: Financial leverage ratio has a positive effect on the profitability of the aviation industry.

H_3: The liquidity of the aviation industry has a positive effect on the profitability of the industry.

H_4: The size of the aviation industry has a positive effect on the profitability of the industry.

Findings

Introductory statistical information about the variables used in the empirical study is stated in Table 3. Accordingly, the average return on assets of the aviation sector was 91.6%, the average return on equity was 92.9% and the average profitability of sales is 95.5% in the 14-year period between 2008-2021 in Turkey. The average R&D spending of the sector was 5.21 million ₺, and the average asset size was 8.31 billion ₺ (LN=9.860). The Covid-19 pandemic especially effective in our country in 2020 caused a serious decrease in the operating profit of the sector due to the closures in the aviation sector, as in many sectors, and the operating profit of the sector in the relevant year was 80 million ₺. This amount is the lowest level between 2008-2021. On the other hand, when the financial leverage situation of the sector is considered, the average of total debts within total assets is 31.7%. This amount was the lowest level between 2008-2021. On the other hand, the average of total debts within total assets is 31.7% when the financial leverage situation of the sector is considered.

Table 3: Descriptive statistical information

Indicator	ROA	ROE	ROS	R&D	LEV	LIQ	LSIZE
Mean	0,916	0,929	0,955	6,636	0,317	0,277	9,860
Median	0,911	0,927	0,954	6,610	0,298	0,253	9,816
Maximum	0,946	0,959	0,975	7,104	0,525	0,463	10,206
Minimum	0,908	0,910	0,931	6,219	0,214	0,140	9,625
Std. Dev.	0,010	0,011	0,011	0,271	0,077	0,104	0,233
Skewness	2,126	1,318	-0,243	0,268	1,513	0,578	0,281
Kurtosis	6,489	5,507	3,091	2,189	5,442	2,380	1,389
Observations	14	14	14	14	14	14	14

Source: Research Result

Table 4 indicates the Pearson correlation matrix for the variables used in the research model. There is a positive and significant relationship between ROA, ROE and ROS, which are used as dependent variables in multiple regression models, and RDI. In addition, there is a negative and significant relationship between ROE and ROS and LEV. On the other hand, a positive correlation has been identified between ROA and ROE and LSIZE. There is a positive relationship between LIQ variable and ROE and ROS.

Table 4: Pearson's correlation matrix of the variables

Variable	ROA	ROE	ROS	RDI	LEV	LIQ	LSIZE
ROA	1						
ROE	0,900**	1					
ROS	0,528***	0,751*	1				
RDI	0,654**	0,601***	0,450**	1			
LEV	-0,338	-0,522***	-0,528***	0,248	1		
LIQ	0,106	0,128**	0,501***	-0,187***	0,361	1	
LSIZE	0,411*	0,698*	0,308	0,454**	-0,556***	0,161	1

Note: Levels of significance: *p<0.01; **p<0.05; ***p<0.10

Source: Research Result.

The results of the regression analysis for the research models are illustrated in Table 5. In the analysis, firstly, the basic assumptions of the regression analysis were tested for all three models. The Variance Inflation Factor (VIF) has been investigated whether there is a multi-linear connection problem between the arguments in the models. The fact that VIF value is between 1 and 5 indicates that there is no multi-linear connection problem (Sarıkovanlık et al., 2019, p. 54). There is no autocorrelation problem between variables based on VIF values for the arguments in the models. On the other hand, the Jarque-Bera technique has been used to determine if error terms are appropriate for normal distribution. In line with the results obtained (Prob.> 0.05), the models indicates that error terms have normal distribution. Breusch-Pagan-Godfrey test has been conducted to investigate whether there is a problem of unstable variance (covariance) in the models. According to the table, the model does not have a problem of unstable variance. The White test could not be performed due to the insufficient number of observations.

According to the results of the regression analysis, a statistically positive and significant relationship was determined between profitability indicators (ROA, ROE, ROS) and RDI. In other words, a 1% increase in the RDI variable can lead to an increase of 13.292% in ROA, 14.270% in ROE, and 16.493% in ROS. A positive and statistically significant relationship was found between LIQ and LSIZE variables, which were found as control variables in the model, and ROA, ROE and ROS. On the other hand, there was a statistically insignificant relationship between the LEV variable and ROA and ROE, while a negative and significant relationship was found between LEV and ROS.

Table 5: Results from multiple regression analysis

Variables	ROA (Model 1)		ROE (Model 2)		ROS (Model 3)		
	Coef.	P-value	Coef.	P-value	Coef.	P-value	VIF
RDI	13,292	0,000*	14,270	0,022**	16,493	0,041**	4,081
LEV	0,006	0,642	0,020	0,574	-0,096	0,003*	2,003
LIQ	0,050	0,040**	0,078	0,004*	0,113	0,000*	1,723
LSIZE	0,097	0,004*	0,110	0,002*	0,045	0,046**	2,451
Jarque-Bera	0,608	0,737	0,429	0,806	0,444	0,800	
Breusch-Pagan-Godfrey (n*R^2)	0,193	0,934	0,391	0,809	0,774	0,575	
F-statistic	9,581	0,005*	11,772	0,003*	19,506	0,000*	
R^2	0,657		0,670		0,311		

Note: Levels of significance: *$p<0.01$; **$p<0.05$; ***$p<0.10$*

Source: Research Result.

The summary results regarding the hypotheses in the empirical study are shown in Table 6. In line with the results obtained from the analyzes, the H$_1$, H$_3$ and H$_4$ hypotheses were accepted. On the other hand, hypotheses H$_2$ was rejected.

Table 6: Summary results of the hypotheses

Hypothesis	Result
H$_1$: R&D spendings have a positive effect on the profitability of the aviation industry.	Accepted
H$_2$: Financial leverage ratio has a positive effect on the profitability of the aviation industry.	Rejected
H$_3$: The liquidity of the aviation industry has a positive effect on the profitability of the industry.	Accepted
H$_4$: The size of the aviation industry has a positive effect on the profitability of the industry.	Accepted

CONCLUSION

It can be emphasized that R&D activities play an substantial role in countries' economic development and growth goals. Companies that make up sectors in national economies require new technologies and knowledge to progress their competitiveness and financial performance on the market. The main aim of

R&D activities is to identify the needs of consumers correctly and to provide the most suitable product or service. In this context, the aviation sector is among the sectors where R&D activities are carried out. The aviation industry includes sub-service groups such as airports, airline transportation, cargo facilities, terminals, ground handling services. The aviation sector is one of the sectors with the highest technological intensity in the world and in Turkey.

Due to the Covid-19 pandemic, which has affected the whole world since 2020, the aviation sector has been adversely affected in terms of financial performance, as in many sectors and fields. The spread of the Covid-19 pandemic through respiration and contact has led states to take precautions at their borders. In this context, countries have taken decisions to limit and stop international flights and then domestic flights. During the pandemic period, serious decline happened in the operating profitability of the aviation industry in Turkey, as in the rest of the world. With the vaccine developed, normalization steps were taken as of 2021 and an improvement and an upward trend started in the financial performance of the sector.

In line with the information above, in this study, the reflection of R&D spending on the financial performance of the Turkish aviation industry was investigated. In this direction, three research models were established in the empirical study. In the models, ROA, ROE and ROS variables of the industry were used as the dependent variables as the financial performance indicator of the aviation industry. On the other hand, R&D intensity of the sector was taken as independent variable. Moreover, LIQ, LEV and LSIZE were used as a control variables in the models. Financial data for the 14-year period between 2008-2021 were analyzed by regression analysis, one of the econometric analysis methods. Before the regression analysis, basic assumptions were tested and then the data were subjected to regression analysis.

According to the assumptions of the regression analysis, it was determined that there was no multicollinearity problem between the independent and control variables in the model, and the error terms had a normal distribution. In addition, there was no problem of varying variance and autocorrelation in the models. On the other hand, the models were found to be significant as a whole. Accordingly, a 1% increase in the RDI variable provides a 13,292% increase in the return on assets (ROA) of the aviation industry regarding the results of the first research model regression analysis. Also, an increase in the control variables LIQ and LSIZE causes an increase in ROA. In the results of the second research model, a 1% increase in the RDI variable causes an increase of 14,270% in the return on equity (ROE) of the aviation industry. A statistically positive and significant relationship was revealed between the control variables LIQ and LSIZE and ROE. Finally, a 1% increase in RDI results in a 16,493% increase in ROS in the third research model. On the other hand, a 1% increase in the LIQ variable causes an 11% increase in ROS, while the LSIZE variable causes an increase of 4%. These results show parallelism with the results of Chin and Tay (2001), Muramalla

and Altamimi (2014), Huang (2021) studies investigating the relationship between the aviation sector and financial performance. In other respects, Hidalgo and Palomares (2022) are also consistent with the results of the studies by examining the relationship between the aviation industry and innovation, Jomo et al. (2017). Apart from these studies, it also shows parallelism with the results of other studies in the literature (Freihat and Kanakriyah, 2017; Kılıç, 2020; Pham et al., 2021; Tung and Binh, 2021).

When the findings in the study are evaluated theoretically, most of the classical models are related to technological innovation. It is required to use tools to design methodologies and strategies for R&D and innovation, to analyze factors that interfere with innovation, and to identify opportunities and threats that exist in different scenarios in these models, the technological innovation audit model (Chiesa, Coughlan, and Voss, 1996), and the process of innovation management model (Tidd et al., 1997), (D'Alvano and Hidalgo, 2012) . Hence, long-term agreements containing technological developments in this field should be developed in order to implement R&D and innovation strategies in the aviation sector. In addition, process innovation, changing market needs and customer expectations are also extremely important. On the other hand, if innovation is not well integrated with the general strategy of the firm or sector, it may cause a decrease in productivity and profitability. Therefore, innovative activities will create competitiveness not only for airline companies but also for the aviation industry. As a consequence, in this study, positive affect of R&D spending in Turkish aviation sector have been observed on the financial performance of the sector. In other words, as R&D spending will increase, operating profit, revenue and operating profit margin, which has been used as financial performance indicators of the sector, will also increase. These increases occur with a delay after R&D spending are made. In this context, as the resources allocated to R&D spending in the sector increase, the opportunities for products and services with high added value will expand, and this situation will have a positive affect on financial performance. With the development of the aviation sector, communication and transportation related to international trade, tourism and investments will be facilitated and will contribute to the growth of the sector and the country's economy. In future research, financial performance of the aviation sector can be compared with the financial performance of other sectors.

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