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MUHASEBE FİNANSMAN (İNGİLİZCE) YÜKSEK LİSANS PROGRAMI

THE IMPACT OF INNOVATIVE ACTIVITIES ON FINANCIAL PERFORMANCE OF THE FIRMS LISTED ON BORSA İSTANBUL

Yüksek Lisans Tezi

BERAT BAŞAT

İstanbul, 2026

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İstanbul, 2026

ÖZET

İNOVATİF FAALİYETLERİN BORSA İSTANBUL'DA İŞLEM GÖREN FİRMALARIN FİNANSAL PERFORMANSI ÜZERİNDEKİ ETKİSİ

İnovasyon, şirketlerin sürdürülebilir büyüme süreçleri ve uzun vadedeki başarıları için kritik bir unsurdur. Şirketlerin, yeni ürünler çıkarması, hizmetlerin kapsamını genişletmesi veya mevcuttaki iş süreçlerini dönüştürmesi için yaptığı yatırımlar, rakiplerinden ayrışmalarını ve piyasada farklılaşmalarını sağlar. İnovasyona önem veren ve devamlı inovatif faaliyetlerde bulunan şirketler, büyüme potansiyelini ve sağlam bir vizyon sunduğunu göstererek, potansiyel yatırımcılarına ve piyasalara yönelik güven tesis eder. Bu çerçevede, bu tez, Borsa İstanbul'da (BİST) işlem gören şirketlerin, inovatif faaliyetleri ile finansal performansları arasındaki ilişkiyi araştırmaktadır. 2013-2022 yılları arasındaki dönemi kapsayan çalışmada panel veri metodolojisi kullanılmıştır. Finansal performans, aktif karlılığı (ROA) ve özsermaye karlılığı (ROE) ile temsil edilirken, inovatif faaliyetler Araştırma ve Geliştirme (Ar-Ge) yoğunluğu ile bir yıl gecikmeli Ar-Ge yoğunluğu kullanılarak temsil edilmektedir. Bu çalışma, diğer çalışmalardan farklı olarak Ar-Ge yoğunluğu hesaplamasında hem giderleştirilen hem de aktifleştirilen Ar-Ge harcamalarını dikkate almıştır. Ayrıca Ar-Ge harcamaları altında yer alan amortisman giderleri ve itfa payları, aktifleştirilen Ar-Ge'nin çalışmaya dahil edilmesi sebebiyle çift etki yaratmaması adına çalışmadan çıkarılmıştır. Dolayısıyla hem kâr veya zarar tablosundaki hem de finansal durum tablosundaki Ar-Ge etkilerini kapsayacak şekilde kurgulanmıştır. Bu bakış açısından, bu çalışma mevcut literatüre katkı sağlamayı ve konu üzerine yapılan önceki araştırmaları geliştirmeyi amaçlamaktadır. Analiz sonuçlarına göre Ar-Ge yoğunluğu ile ROA arasında önemli ve pozitif bir ilişki tespit edilirken, ROE ile bir ilişki tespit edilememiştir.

Anahtar Kelimeler: Araştırma ve Geliştirme (Ar-Ge), Finansal Performans, İnovatif Faaliyetler, Panel Veri Metodolojisi

ABSTRACT

THE IMPACT OF INNOVATIVE ACTIVITIES ON FINANCIAL PERFORMANCE OF THE FIRMS LISTED ON BORSA İSTANBUL

Innovation is a vital element in firms' sustainable growth processes and long-term success. Firms' investments through introducing new products, expanding service offerings or transforming operational processes allow to differentiate themselves from their competitors and position in the market. Firms that attach great importance to innovation and continuous innovative activities inspire confidence to potential investors and build trust in markets by showing growth potential and a solid vision. In this context, this thesis investigates the correlation between innovative activities and the financial performances of firms listed on Borsa İstanbul (BİST). The analysis was conducted by using panel data methodology for 2013-2022 period. Financial performance is represented by return on assets (ROA) and return on equity (ROE), while innovative activities are represented by Research and Development (R&D) intensity and one year lagged R&D intensity. This study, unlike the others, considers capitalized and expensed R&D figures to calculate R&D intensity. In addition, depreciation and amortization expenses under R&D expenses were excluded from the study to avoid a double effect due to the inclusion of capitalized R&D in the study. Therefore, it has been designated to cover the R&D effects on the statement of both profit or loss and financial position. From this perspective, this thesis aims to contribute to existing literature and extend previous research on the topic. While the findings reveal a statistically significant and positive relationship between R&D intensity and ROA, no relationship is detected regarding the ROE measure.

Keywords: Research and Development (R&D), Financial Performance, Innovative Activities, Panel Data Methodology

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LIST OF ABBREVIATIONS

R&D	Research and Development
BİST	Borsa İstanbul
İMKB	İstanbul Menkul Kıymetler Borsası
ROA	Return on Assets
ROE	Return on Equity
ROS	Return on Sales
G&A	General and Administration
EPS	Earnings per Share
GMM	Generalized Method of Moments
ROIC	Return on Invested Capital
OLS	Ordinary Least Squares
GLS	Generalized Least Squares
SMEs	Small and Medium Sized Enterprises
EBIT	Earnings before Interest and Taxes
P/B	Market to Book Value
DEA	Data Envelopment Analysis
BCC	Banker, Charnes and Cooper
NYSE	New York Stock Exchange
AMEX	American Stock Exchange
NASDAQ	National Association of Securities Dealers Automated Quotations
CRSP	Center for Research in Security Prices
OECD	Organization for Economic Co-Operation and Development
GDP	Gross Domestic Product
TÜBİTAK	The Scientific and Technological Research Council of Türkiye
PDP	Public Disclosure Platform
TAS	Turkish Accounting Standards
IAS	International Accounting Standards
TFRS	Turkish Financial Reporting Standards
VUK	Tax Procedural Law
TurkStat	Turkish Statistical Institute
SBB	Turkish Presidency – Directorate of Strategy and Budget
ROW	Rest of the World
KPI	Key Performance Indicators
ICT	Information and Communication Technology
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
VAT	Value Added Tax
KOSGEB	Small and Medium Enterprises Development Organization
VIF	Variance Inflation Factor
EU	European Union

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1.INTRODUCTION

In today's global economy, the capacity for innovation and ongoing technological progress are playing a key role which shapes a nation's competitive edge. Since the industrial revolution, significant restructuring has occurred in the hierarchy of factors of production. Accordingly, traditional components, especially physical capital and labor, have been supplemented by knowledge, technology and innovation. All of them constitute the core driver of economic development. The strategic position of R&D in national development policies has increased with these developments (OECD, 2021). The most important of these developments are the current breakthroughs in digital transformation, artificial intelligence, sustainable energy and green technologies. As a result, the role of R&D is gradually expanding and becoming multifaceted. Today, R&D is not only the foundation of scientific progress but also viewed as a strategic investment tool because it strengthens social welfare, transforms export structures, and creates sustainable added value (Fırat et al., 2016). Through R&D, companies increase their productivity and achieve market superiority. Accordingly, most of the research in literature examines the R&D impact on the performance of businesses.

According to Turkish and International Accounting Standard (TAS & IAS) 38, R&D is defined in two stages: research and development. Research encompasses original and systematic activities aimed at accessing new, previously undiscovered scientific or technical data. The development stage is the transformation of knowledge into new or significantly improved processes, products or services. This difference demonstrates that R&D encompasses not only the production of knowledge but also the commercialization of this acquired knowledge. Therefore, companies gain sustainable competitive advantage by developing innovative solutions.

Türkiye has taken significant steps toward R&D and innovation to reduce external dependency and increase domestic production. According to the 2024 Research and Development Activities Survey conducted by the Turkish Statistical Institute (TurkStat), the proportion of R&D expenditures relative to gross domestic product (GDP) shows a steady upward trend over the period from 2009 to 2024. In order to assess the role of a country’s R&D expenditure in economic growth, it is important to consider its proportion within the total income generated by the economy. Accordingly, R&D expenditures are evaluated as a percentage of GDP. While this rate was 0.80% in 2009, it rose to 1.46% in 2024. R&D expenditure reached to 651,8 billion TL and Türkiye's GDP reached to 44,6 trillion TL in 2024 (TurkStat, 2025).

Incentives related to R&D are also crucial for Türkiye to enhance its international competitiveness, reduce its external dependence, and maintain sustainable growth. According to Cohen and Levinthal (1990) and Loursen and Salter (2014), firms invest more in R&D activities to develop new products, increase productivity, and implement more efficient operational processes. Although firms and organizations often view R&D activities as a cost in the short run, these activities represent a long-term investment that generates future cash flows through the products developed as a result of innovative activities.

In terms of accounting of R&D spendings, while the provisions of the Turkish and International Accounting Standard (TMS/UMS 38) require some R&D expenses to be recorded as direct costs, they allow development expenses that meet certain criteria to be capitalized within the scope of intangible assets (IAS 38, 21). These differences in accounting practices can cause even R&D expenditures of the same nature to be reflected differently in the financial statements and, accordingly, affect corporate performance indicators in various ways. Recognizing expenditures as expenses in the period incurred can reduce short-term profitability, whereas capitalization may have a favorable effect on ratios like return on equity (ROE) and return on assets (ROA) (Lev, 2001; Hsu et al., 2014). Therefore, when analyzing the impact of R&D on the financial output of enterprises, not only the total amount of expenditure but also the capitalized component itself is an element that must be analytically considered. For that reason, this study includes expensed R&D and capitalized R&D for taking into account of total R&D spending.

This thesis examines the relationship between the role of innovation and accounting-based financial performance measured through the use of ROA and ROE. The study was conducted on 66 firms selected from 113 BİST listed firms, based on complete data and continuous operation for the years between 2013 and 2022.

The remainder of the study consists of 5 main sections. The following section describes the conceptual framework of R&D. Section 3 is devoted to a literature review covering the theoretical framework and empirical research in Turkish and international literature. Section 4 details the research design including dataset, variables, hypothesis and methodology performed in the study. Empirical findings are presented in Section 5 and last section concludes by summarizing the study's results and implications together with suggestions for further studies.

2. GENERAL FRAMEWORK OF RESEARCH AND DEVELOPMENT (R&D)

According to the Oslo Manual, innovation is defined as the introduction of a new or significantly improved product or process. It can also be defined as mix of the two that differ from the unit's previous versions, which either becomes available to potential users (as a product) or is put into practice by the unit itself (as a process). Innovation activities cover every developmental, financial or commercial effort a firm undertakes with the aim of producing an innovation. Companies or organizations conduct R&D activities for innovative work. Innovative activities encompass R&D but do not consist entirely of R&D. According to definition of OECD (2015), R&D is systematic efforts undertaken to uncover undiscovered knowledge, transform existing knowledge into applied results, and generate innovative solutions to operational processes. Innovative activities contribute to the advancement of technology and scientific knowledge by improving existing knowledge and aiming to uncover undiscovered products, processes, or results, or to obtain new, undefined scientific data. Macroeconomic variables or external shocks, such as wars, pandemics, global economic crises, and disasters, have strong short- and medium-term effects on the economy. However, technological improvements are critical for long-term sustainable economic growth and increased resilience to external influences. Technology has a direct impact on R&D activities. It is one of the most decisive factors accelerating innovation production and productivity growth.

R&D intensity is a measure that shows the level of a country's national income which is allocated to R&D activities (Kısakürek and Gönen, 2021, 22). The R&D intensity reveals valuable information about a country's technological progress, socioeconomic structure and level of prosperity. It also provides crucial information for policymakers and industry leaders, helping them analyze data such as a country's or firm's commitment to innovation, its effectiveness in knowledge investments, and its competitiveness. The R&D intensity is calculated by looking at the ratio of a country's total R&D expenditure to GDP or a company's total turnover (Gök and Balaban, 2018, 61). Furthermore, organizations with high R&D intensity generally embrace and prioritize innovation. This also shows that organizations have high productivity and generate value-added work. This demonstrates that R&D is not merely a cost driver but also a key indicator of the capacity to adapt to technological change and global competition. There is a strong correlation between the development of high-technology industries, the growth of data and knowledge-based sectors, and the ability to sustain long-term economic growth. Countries with higher R&D intensity tend to produce more patent applications, scientific publications, and technological innovations. In turn, they increase their trade potential by competing in both domestic and international markets. In addition to measuring the overall level of R&D focus in an economy, the R&D intensity

metric also reveals sectoral priorities and investment patterns. For example, in emerging economies, R&D intensity may be clustered in specific sectors, such as information technology, pharmaceuticals, or manufacturing, reflecting targeted strategies to enhance competitiveness. At the institutional level, R&D intensity concretely demonstrates the strategic value placed on innovation and the potential for market differentiation through innovative products, services, or processes.

R&D activities are generally considered in three main areas, as accepted in the literature. The first one is basic research. It aims to generate new knowledge through observational and experimental methods without a specific goal. The second one is applied research, which seeks to improve processes and broaden product ranges to boost business competitiveness. The last one is experimental development, which concentrates on refining existing products and production processes thereby delivering a competitive edge. When the insights collected from these studies are turned into products, they increase market value on both domestic and international markets. Consequently, while R&D activities increase export volumes, it decreases the pressure on the current-account balance and fuels economic development. For that reason, businesses and nations create opportunities for their technological processes and niche market segments by empowering the innovative activities in this era of accelerating global competition.

R&D activities stand as long-term investments aimed to broaden the knowledge base of individuals, societies and cultures. This point is reinforced by Article 2/a of Law No. 5746 (Gazette of the Republic of Türkiye March 12, 2021). They also focus on problems related to technological and scientific uncertainty while they are producing innovative information technology solutions and environmentally suitable outputs. The result is a flow of practical and highly technical outcomes. For that reason, all these outcomes are considered as strategic investments which support a country's economic independence and technological competence.

In modern economies, R&D serves a twin purpose: it drives technological improvements while simultaneously support overall economic expansion. Countries that allocate more resources to R&D typically enjoy a share of value-added output. The new technologies developed through R&D allow countries to strengthen their position in the global market. Accordingly, countries establish a solid foundation for minimizing the effect of economic fluctuations and long-term sustainable development.

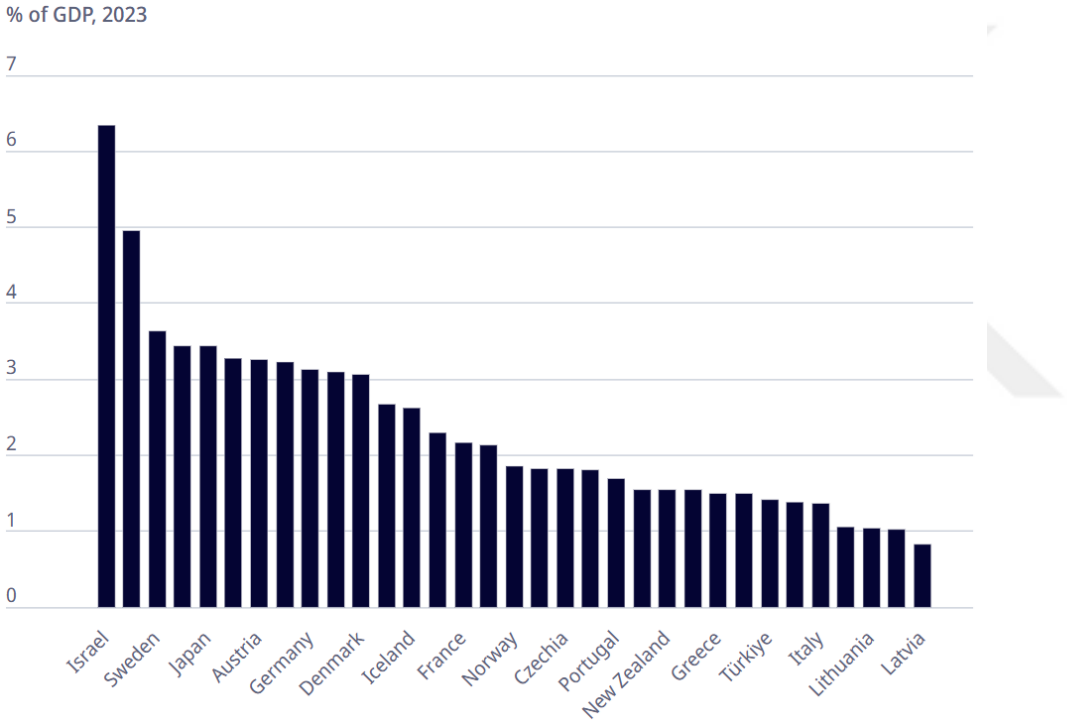
In conclusion, R&D activities contribute significantly to innovation, economic expansion, and technological advancement. The level of R&D intensity shows how much countries invest in knowledge and how strongly they aim to build an innovative-based economy. Around the world, countries differ in their R&D intensity depending on their economic strength and policy priorities.

The next part explains Global and Türkiye's R&D Intensity and shows how countries invest in R&D in different ways.

2.1.Global R&D Intensity

When the investment trends are examined year over year, R&D activities have increased globally. In this context, according to the latest OECD data, the average R&D intensity of member countries in 2023 was higher than the previous year. Figure 1 presents R&D expenditures to GDP in 2023. Based on figure 1, Israel increased its gross domestic spending on R&D to 6.3% and Korea 5%, followed by Sweden at 3.6%, and the United States and Japan at 3.4% in 2023. Across member countries, the average R&D intensity reached 2.7% in 2023 while this rate was 2.6% in 2022 (OECD, 2024). These figures show that continuous investment in R&D expenditure is increasing, and thus scientific competition is also increasing in parallel.

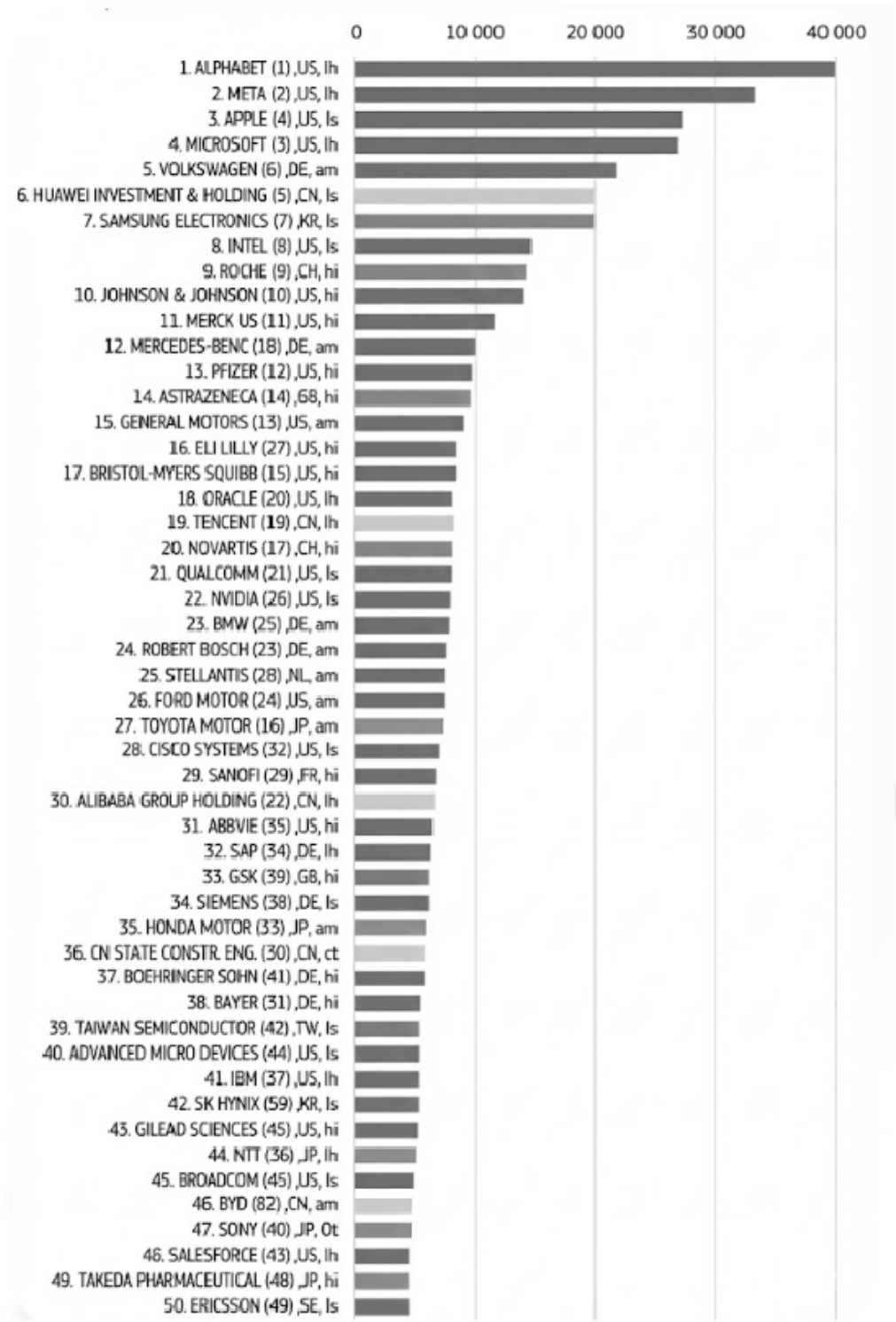
Figure 1: R&D expenditures to GDP, 2023



Source: *OECD (2025, October 25), "Gross Domestic Spending on R&D".*
https://www.oecd.org/en/data/indicators/gross-domestic-spending-on-r-d.html

When looking at R&D intensity across companies, it is seen that R&D spending by global companies is concentrated in a few high-technology sectors and multinational corporations. The top 2,000 companies with the highest R&D expenditure worldwide are listed and analyzed in the European Union (EU) Industrial R&D Investment Scoreboard (2024) report. These top 2,000 companies account for 85% to more than 90% of global R&D. Figure 2 does not list all 2,000 companies, but it does present the top 50 companies with the highest R&D investments. According to Figure 2, the majority of these top 50 companies are US-based (22 companies). EU-based companies follow closely behind 11 companies.

Figure 2: Top 50 R&D Investors in 2024



Notes: Figures are shown in EUR Million. Is=ICT software, Ih=ICT hardware, am=automotive, hi=health industries, ct=constructions, Ot=others. Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Table 1 shows the key performance indicators by region or countries. In 2023, the country with the highest R&D intensity was the US, at 8.4%. US companies, leading in R&D intensity, have an average of twice that of the EU and Japan. The total R&D expenditure of Scoreboard companies in the US in 2023 was €531.8 billion. The leading sectors driving R&D intensity in the US are Information and Communication Technology (ICT) Software with 34.2% amounting to €181,6 billion, healthcare with 25.4% amounting to €135 billion, ICT hardware with 23.4% amounting to €124,3 billion, and automotive with 6.4% amounting to €34,1 billion account for more than 89% of the total R&D of the Top 2000 firms in the US. The average R&D intensity for the EU is 4.2%, Japan at 4.2%, China at 3.9%, the rest of the world (ROW) at 3.7%, and the total of Top 2000 global firms at 5.1%. Global R&D intensity in 2023 is reported to have increased compared to the prior year. Accordingly, the total R&D intensity of the Top 2000 global firms was 4.8% in 2022, rose to 5.1% in 2023.

Table 1: Business Key Performance Indicators (KPI), 2023

Category	EU	US	China	Japan	ROW	Total
Companies	322	681	524	185	288	2.000
R&D investment, EUR bn	**235,2**	**531,8**	**215,8**	**104,8**	**169,9**	**1.256,6**
One-year change	9.8%	5.9%	9.6%	7.1%	9.1%	7.8%
Net sales, EUR bn	5.607	6.277	5.476	2.558	4.555	24.474
One-year change	3.5%	2.5%	7.0%	4.1%	-12.4%	0.6%
R&D intensity	**4.2%**	**8.4%**	**3.9%**	**4.2%**	**3.7%**	**5.1%**
Operating profits, EUR bn	618,2	956,4	368,6	206,3	725,2	2.874,0
One-year change	13.2%	3.1%	-1.0%	16.7%	-34.1%	-8.0%
Profitability, %	11.0%	15.4%	6.7%	8.1%	16.0%	11.8%
Capex, EUR bn	373,3	400,0	402,8	156,4	368,9	1.701,0
One-year change	20.6%	12.3%	-0.7%	12.0%	6.7%	9.3%
Capital intensity	6.7%	8.4%	3.9%	6.1%	8.1%	7.0%
Employment, million	15,2	10,8	15,2	7,6	6,3	55,2
One-year change	3.4%	-0.7%	4.1%	-2.8%	-13.9%	-0.4%
R&D per employee, EUR	15.427	48.593	14.137	13.713	17.706	21.575
Market capitalization, EUR bn	6.011	23.555	3.556	3.002	7.800	43.924
One-year change	23.3%	23.7%	0.15%	41.4%	14.0%	21.0%

Note: Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Comparatively, by country, R&D intensity in the US increased from 8.1% in 2022 to 8.4% in 2023, the EU from 4.0% to 4.2%, and Japan from 4.0% to 4.1%. China experienced the smallest increase, rising from 3.8% in 2022 to 3.9% in 2023. The rest of the world documented a significant increase from 3.0% to 3.7%. This increase stemmed from the stronger increase in R&D relative to net sales.

A sector-by-sector assessment of R&D intensity reveals that the ICT (software and hardware), healthcare and automotive sectors are leader sectors. Table 2 shows KPI for the ICT software sector and reveals that the US increased its R&D intensity from 9.5% in 2013 to 15% by 2023. At the same time, the US has increased its profit margin to 23.4%, giving it the highest profitability rate.

Table 2: KPIs of the ICT Software Sector by Region/Country for the period 2013-2023

ICT Software	Year	n	R&D	Operating Profit	Sales	Capex	Profitability	R&D intensity	Capex intensity	R&D per employee
EU	2013	33	8.130	34.759	245.403	28.425	14.2%	3.3%	11.6%	8.577
	2023	24	17.983	45.827	317.013	34.676	14.5%	5.7%	10.9%	20.024
	Growth		121,2%	31,8%	29,2%	22,0%				
US	2013	123	46.931	116.002	491.604	40.784	23.6%	9.5%	8.3%	32.973
	2023	163	181.630	281.051	1.206.744	125.530	23.4%	15.0%	10.4%	92.557
	Growth		287,0%	142,3%	145,5%	207,8%				
China	2013	24	2.448	4.988	31.951	1.597	15.6%	7.7%	5.0%	9.067
	2023	68	37.595	59.412	513.669	45.736	11.6%	7.3%	8.9%	21.600
	Growth		1435,8%	1090,9%	1507,6%	2762,2%				
Japan	2013	8	3.849	9.533	118.085	10.775	8.1%	3.3%	9.1%	7.358
	2023	7	10.219	16.920	173.074	18.439	9.8%	5.9%	10.7%	15.644
	Growth		165,5%	77,5%	46,6%	71,1%				
ROW	2013	43	4.187	17.949	174.395	20.241	10.3%	2.4%	11.6%	3.847
	2023	38	12.166	17.417	168.094	14.058	10.4%	7.2%	8.4%	12.676
	Growth		190,5%	-3,0%	-3,6%	-30,5%				

Note: Figures are shown in EUR Million. n: number of companies. Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Table 3 shows that the EU continues to see growth in the automotive sector (2013: 5.2% & 2023: 5.7%). China, one of the countries that increased R&D intensity the most, showed an increase of over 2.5% in the automotive sector, demonstrating a shift from production to R&D-focused growth (2013: 2.5% & 2023: 5.5%). The US also increased its R&D intensity in the automotive sector from 3.8% to 4.7%. Japan, on the other hand, experienced the largest decrease, dropping its R&D intensity from 4.1% to 3.7%.

Table 3: KPIs of the Automotive Sector by Region/Country for the period 2013-2023

Automotive	Year	n	R&D	Operating profit	Sales	Capex	Profitability	R&D intensity	Capex intensity	R&D per employee
EU	2013	36	42.814	50.714	822.685	48.004	6.2%	5.2%	5.8%	16.600
	2023	37	84.090	124.461	1.467.308	67.179	8.5%	5.7%	4.6%	18.830
	growth		96.4%	145.4%	78.4%	39.9%				
US	2013	34	20.578	41.126	542.092	29.463	7.6%	3.8%	5.4%	16.011
	2023	32	34.082	54.208	716.467	54.558	7.6%	4.7%	7.6%	26.962
	growth		65.6%	31.8%	32.2%	85.2%				
China	2013	22	3.761	5.659	148.919	6.866	3.8%	2.5%	4.6%	4.193
	2023	40	25.472	11.435	464.431	35.587	2.5%	5.5%	7.7%	12.166
	growth		577.2 %	102.1%	211.9%	418.2%				
Japan	2013	39	21.304	38.268	516.257	43.571	7.4%	4.1%	8.4%	11.902
	2023	26	30.980	71.840	834.756	50.817	8.6%	3.7%	6.1%	16.786
	growth		45.4%	87.7%	61.7%	16.6%				
ROW	2013	23	6.131	17.603	221.338	10.151	8.0%	2.7%	4.6%	7.524
	2023	18	10.676	31.302	384.182	14.581	8.1%	2.8%	3.8%	13.100
	growth		74.1%	77.8%	73.6%	43.6%				

Note: Figures are shown in EUR Million. n: number of companies. Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Table 4 demonstrates that Japan is the country that increased its R&D intensity the most in the healthcare sector. Japan increased its R&D intensity from 12.1% to 15.5%. The US followed closely behind, increasing its R&D intensity from 11.0% to 13.0% in the healthcare sector, the EU from 10.2% to 12.7%, and China from 3.4% to 7.2%. Therefore, the sectors ranked in terms of R&D intensity are ICT hardware, ICT software, healthcare and automotive, respectively.

Table 4: KPIs of the Healthcare Sector by Region/Country for the period 2013-2023

Health	Year	n	R&D	Operating profit	Sales	Capex	Profitability	R&D intensity	Capex intensity	R&D per employee
EU	2013	65	22.127	31.442	216.033	10.118	14.6%	10.2%	4.7%	23.056
	2023	64	45.950	49.865	359.025	22.012	13.9%	12.7%	6.1%	36.289
	growth		106.0%	58.6%	66.2%	117.5%				
US	2013	153	59.790	85.069	538.265	17.247	16.0%	11.0%	3.2%	55.279
	2023	238	134.977	98.611	986.926	34.284	10.7%	13.0%	3.5%	85.616
	growth		125.8%	15.9%	83.4%	98.8%				
China	2013	13	625	2.673	18.605	1.820	14.4%	3.4%	9.8%	4.333
	2023	63	13.177	12.756	181.729	9.685	7.2%	7.2%	5.3%	17.312
	growth		2007.2%	377.2%	876.8%	432.1%				
Japan	2013	36	9.220	7.859	76.076	2.499	10.3%	12.1%	3.3%	32.654
	2023	21	16.060	11.328	103.818	5.051	10.9%	15.5%	4.9%	55.768
	growth		74.2%	44.2%	36.5%	102.1%				
ROW	2013	42	31.408	48.053	217.693	10.256	22.3%	14.4%	4.7%	51.663
	2023	51	48.277	53.907	283.463	12.857	19.1%	16.9%	4.5%	71.476
	growth		53.7%	11.1%	30.2%	25.4%				

Note: Figures are shown in EUR Million. n: number of companies. Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I

Total R&D expenditures by the Top 2000 companies in 2023 reached EUR 1,256.6 billion, a 7.8% increase compared to 2022. Table 5 demonstrates the distribution of the Top 2000 companies, in terms of their percentage share of total global R&D investment, within each region or country. Accordingly, the total R&D expenditures by EU companies among the Top 2000 companies' R&D investors increased by 9.8% to €235.2 billion. Therefore, it appears that the EU surpassed China in 2023. China increased by 9.6% with €215.8 billion, the US by 5.9% with €531.8 billion, and Japan by 7.1% with €104.8 billion. The US is the largest R&D investor with €531.8 billion. Among EU countries, Germany ranks first with €119.2 billion.

According to Table 5, among the Top 2000 global companies, 681 companies are based in the US, accounting for 42.3% of total global R&D investment, making it the largest share. This demonstrates that US companies' R&D expenditure is significantly higher than other companies. It can be noted the US's financial superiority in the innovation ecosystem. EU companies, with a total of 322 EU companies, account for 18.7%. Germany alone accounts for almost half of this share. With 106 companies and a

46.5% share within the EU, Germany accounts for 8.99% of all global R&D investment. France and the Netherlands, with 2.7% and 2.4%, respectively, represent a considerable portion of the European Union's total share.

China follows the US with 524 companies, representing a 17.1% share. In previous years, Chinese companies' R&D expenditures have been slower. Japan, on the other hand, has 185 companies among the Top 2000 global companies, representing 8.3% of total global R&D investment. While Japan has fewer companies than other countries, its share of R&D expenditures is substantial, despite this small size.

Table 5: Number of Companies in the Top 2000 Companies by Country/Region and Their R&D Investments in 2023

EU countries	Number of Companies	R&D (EUR bn)	Non-EU countries	Number of Companies (Non-EU)	R&D (EUR bn, Non-EU)
Germany	106 (95)	119,2	**US**	681 (686)	531,8
France	50 (49)	33,7	**China**	524 (507)	215,8
Netherlands	33 (33)	29,8	**Japan**	185 (188)	104,8
Sweden	22 (20)	15,3	**Switzerland**	39 (39)	36,2
Ireland	24 (24)	10,4	**South Korea**	40 (40)	42,5
Denmark	23 (22)	9,8	**UK**	63 (70)	35,4
Finland	9 (9)	5,4	**Taiwan**	55 (61)	24,7
Italy	17 (16)	5,4	**India**	15 (17)	5,5
Spain	11 (11)	5,6	**Canada**	24 (23)	8,2
Belgium	9 (10)	3,2	**Israel**	19 (19)	3,7
Austria	11 (10)	1,9	**Australia**	7 (9)	4,2
Luxembourg	3 (4)	1,9	**Singapore**	8 (7)	2,7
Portugal	1 (1)	0,2	**Brazil**	4 (4)	1,7
Hungary	1 (1)	0,2	**Norway**	2 (2)	0,8
Slovenia	1 (1)	0,2	**New Zealand**	3 (3)	0,4
Malta	1 (1)	0,1	**8 other countries**	8 (8)	2,1
Total EU	**322 (308)**	**235,2**	**Non-EU Total**	**1.678 (1.692)**	**1.022,4**

Note: Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Table 6 shows the shares and changes in the shares of R&D expenditures in the four most intensive sectors, by country or region, between 2013 and 2023 which are ICT Hardware, ICT Software, Healthcare, and Automotive. According to Table 6, 57.2% of the companies in the Top 2000 in 2013 were in these four most intensive sectors. This rate increased to 63.7% in 2023, meaning that companies spending on R&D shifted towards sectors with fewer and more intensive R&D. The increase in the total R&D share also reveals that the share of these four sectors in global R&D has increased (2013: 73.4% & 2023: 78.7%). According to the same table, the US has increased its share in these four most intensive

sectors to nearly 90% (89.3%), making it the country with the highest share of global R&D spending. Following the US share in R&D investment in these four most intensive sectors are ICT software (34.2%), healthcare (25.4%), ICT hardware (23.4%), automotive (6.4%), and other sectors (10.7%). The EU, with a combined share of 76.8% in these four most intensive sectors, surpasses all other regions except the US, (China (61.7%), Japan (73.0%), and the Rest of the World (73.6%)).

Table 6: Distribution of Firms and R&D Investment Shares in Top 4 Sectors Across Regions, 2013 and 2023

	Share of firms			Share of R&D		
	2013	**2023**	**PP change**	**2013**	**2023**	**PP change**
EU	44.6%	49.4%	+4.7	70.3%	76.8%	+6.5
US	72.8%	79.7%	+6.9	81.5%	89.3%	+7.8
China	57.6%	56.1%	-1.5	57.3%	61.7%	+4.4
Japan	44.7%	51.9%	+7.2	66.2%	73.0%	+6.8
ROW	54.1%	62.8%	+8.8	67.9%	73.6%	+5.6
Total	**57.2%**	**63.7%**	**+6.4**	**73.4%**	**78.7%**	**+5.4**

Note: Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Table 7 shows the actual money spent (in millions of Euros) on R&D and relative change over the past 10 years. Accordingly, compared to the last 10 years (2013-2023), it is seen that the figure increased by 119%, from €573.9 billion in 2013 to €1,257.6 billion in 2023 for the top 4 sectors.

Table 7 also shows that the fastest growing sector is the ICT Software sector, with a 4.0-fold increase (The increase is 3.9 times in the US and 2.2 times in the EU). The EU maintains its leading position with €84.1 billion in R&D spending in the automotive sector in 2023. It also accounts for 45.4% of total global automotive R&D spending. Companies based in China constitute the largest proportion of R&D activity in other sectors, surpassing the US and the EU in the "other sectors" category, spending a total of €82.7 billion in R&D, excluding ICT hardware, ICT software, healthcare, and automotive. Between 2013 and 2023, China accelerated its R&D investments, increasing them 7.5 times. The other sectors category includes general industry, consumer goods, retail, media and construction. However, China's fastest-growing sector is healthcare. China experienced significant growth in the healthcare sector, increasing 21.1 times in 2023. Japan shows the lowest growth rate relative to others, with a total growth of 1.4 times.

Table 7: R&D Investments in Top 4 Sectors Across Region/Country: 2013 and 2023

Region	Year	ICT hardware	ICT software	Health	Automotive	Rest	Total
EU	2013	22.410	8.130	22.127	42.814	40.251	135.735
	2023	33.024	17.983	45.590	84.090	54.545	235.233
	Factor change	1,5	2,2	2,1	2,0	1,4	1,7
US	2013	65.093	46.931	59.790	20.578	43.658	236.051
	2023	124.258	181.630	134.977	34.082	56.909	531.858
	Factor change	1,9	3,9	2,3	1,7	1,3	2,3
China	2013	7.941	2.448	625	3.761	11.019	25.796
	2023	56.876	37.595	13.177	25.472	82.692	215.813
	Factor change	7,2	15,4	21,1	6,8	7,5	8,4
Japan	2013	14.825	3.849	9.220	21.304	25.093	74.293
	2023	19.257	10.219	16.060	30.919	28.872	104.790
	Factor change	1,3	2,7	1,7	1,5	1,1	1,4
ROW	2013	27.951	4.187	31.408	6.131	32.697	102.016
	2023	53.892	12.166	48.277	10.676	44.918	169.931
	Factor change	2,0	2,9	1,5	1,7	1,4	1,7
Total	2013	137.863	65.547	123.171	94.590	152.720	573.892
	2023	287.309	259.595	258.083	185.301	267.337	1.257.628
	Factor change	2,1	4,0	2,1	2,0	1,8	2,2

Notes: The factor change is calculated as the ratio of R&D investment in 2023 to R&D investment in 2013 and it demonstrates the relative change over time. Figures are shown in EUR Million. Data are derived from the EU Industrial R&D Investment Scoreboard (2024) of the European Commission, JRC/DG R&I.

Analysis using 2023 data and taking into consideration dynamics in previous decades provides a comprehensive review of R&D intensity and R&D expenses in the Top 2000 corporations in the world in the four main industries identified through highest R&D intensity in the world. All these dynamics are presented in a comparative manner, demonstrating that the US owes its absolute R&D leadership to its extreme focus on sectors such as ICT hardware, ICT software, healthcare and automotive. From a sectoral perspective, an examination of R&D investments in EU reveals that it maintains its leadership, particularly in the automotive sector, and has achieved significant growth in the healthcare sector. China, on the other hand, has increased its R&D expenditures and diversified its R&D investments in automotive and other sectors compared to the US and the EU. This global R&D Intensity matrix provides a necessary benchmarking framework for comparing the performance of BIST companies with international standards of high spending volume and intensity.

R&D intensities are different among the countries. In 2023, the average R&D intensity across OECD countries was approximately 2.7% of GDP (OECD, 2024). Some of countries with R&D intensities above the OECD average are South Korea, Sweden, Austria, Denmark, Germany, the United States,

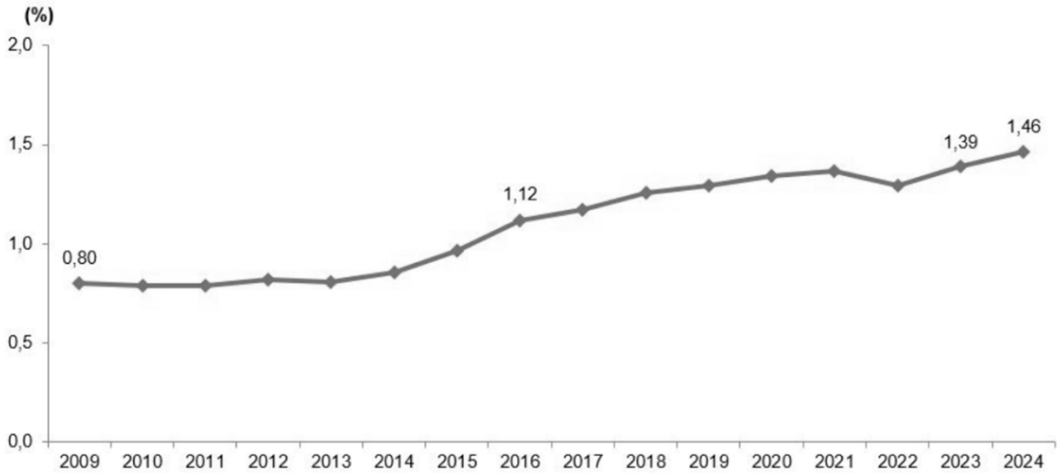
Finland, and Belgium. These countries are making significant investments in R&D. They also demonstrate a stronger capacity to produce high-value-added products and successfully commercialize innovations than other countries. Therefore, higher R&D intensity is associated with enhanced economic growth, technological advancements, and international competitiveness, underscoring the strategic importance of sustained R&D investment for both national and corporate performance (OECD, 2024).

Overall, global R&D intensity continues to rise, driven mainly by strong investments in high-technology sectors such as ICT software & hardware, healthcare, and automotive. Countries and firms that consistently invest in R&D strengthen their innovation capacity, improve competitiveness, and secure sustainable economic growth in the long term.

2.2. R&D Intensity in Türkiye

R&D activities play a significant and active role in a country's economic and sustainable development to raise living standards. Figure 3 shows the share of R&D expenditures in GDP for the years between 2009 and 2024. As it is seen on Figure 3, Türkiye's investments in R&D are increasing gradually. Specifically, looking at the period between 2009 and 2024, R&D expenditure as a percentage of GDP increased from 0.80% to 1.46%. By the end of 2023, R&D expenditures reached 377,5 billion TL. By the end of 2024, R&D expenditure increased by 73%, and reached 651,8 billion TL (TurkStat, 2025). Türkiye's GDP reached to 44,6 trillion TL as of the end of 2024.

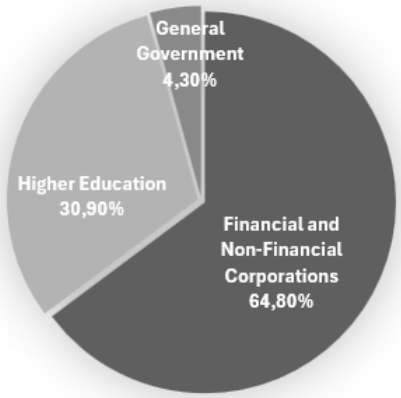
Figure 3: Share of R&D Expenditures in GDP, 2009-2024



Source: *Research and Development Activities Survey, TurkStat (2025)*

Figure 4 presents how R&D investments are allocated across sectors in Türkiye in 2024. Financial and non-financial corporations are in first place, higher education in second place, and general government spending in third place. Non-profit organizations are also included in general government spending. During the same period, 64.8% of total R&D expenditures were made by financial and non-financial corporations, 30.9% by higher education, and the remaining 4.3% by general government.

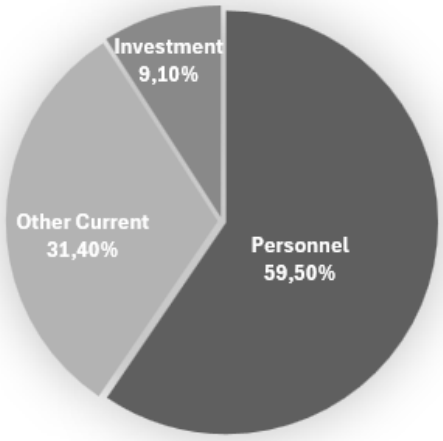
Figure 4: Breakdown of R&D Investments by Sector in Türkiye, 2024



Source: Research and Development Activities Survey, TurkStat (2025)

Figure 5 demonstrates the breakdown of R&D investments by spending group in 2024. Personnel expenditure represents the largest share at 59.5%. Other current expenditures constitute 31.4%, and investment expenditures accounted for 9.1%.

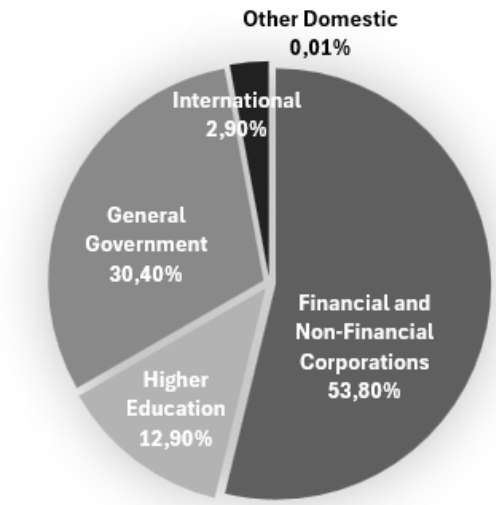
Figure 5: Breakdown of R&D investments by Expenditure Group in Türkiye, 2024



Source: Research and Development Activities Survey, TurkStat (2025)

Figure 6 shows the breakdown of financial resources by sector for 2024. Financial and non-financial companies leading in R&D financing, with 53.8%. This was followed by the general government with 30.4%, higher education with 12.9%, international sources with 2.9%, and the remainder from other domestic sources respectively.

Figure 6: Breakdown of Financial Resources by Sector, 2024

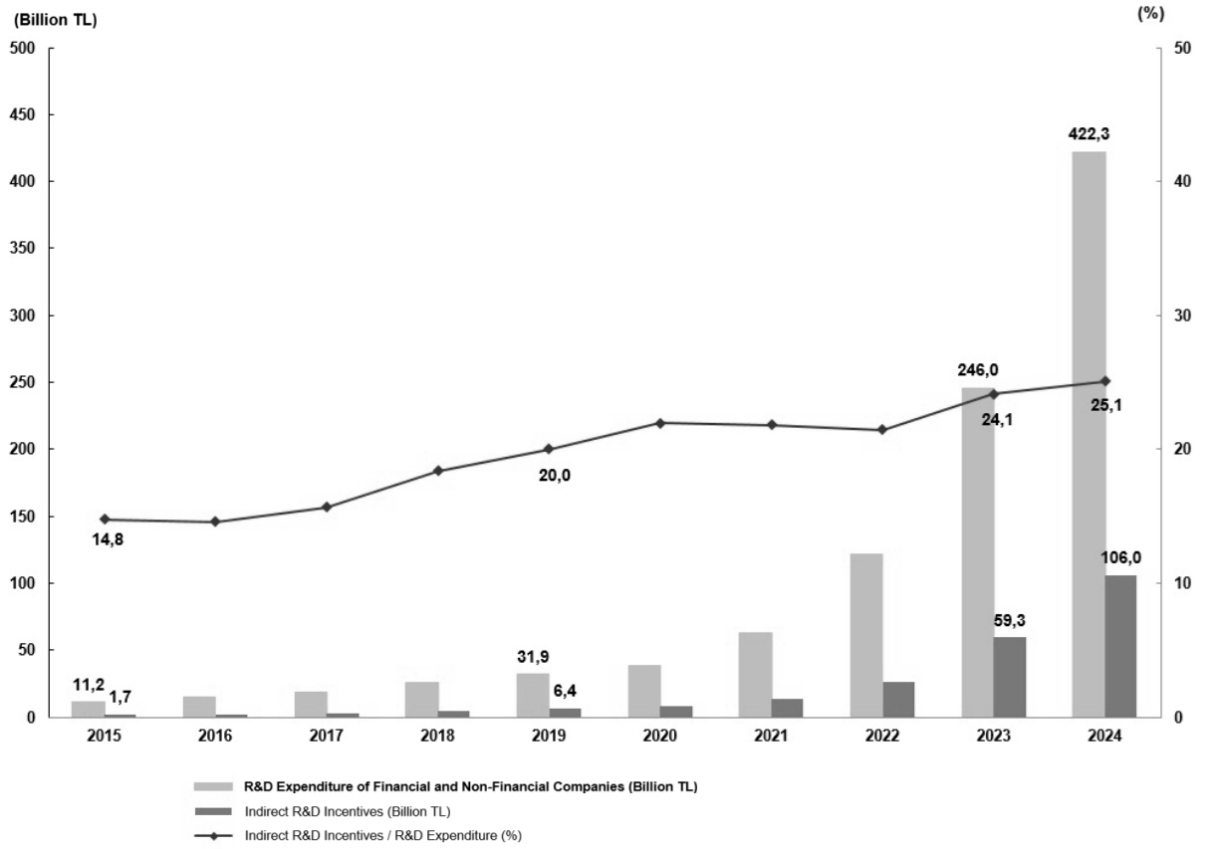


Source: *Research and Development Activities Survey, TurkStat (2025)*

In Türkiye, the government has established a comprehensive framework of incentives to promote R&D. Innovative activities and technological advancement has been prioritized by introducing various incentive mechanisms to enhance industrial competitiveness. Project based incentives also have been developed in Türkiye for R&D activities. These project-based incentives are mainly provided by Small and Medium Enterprises Development Organization (KOSGEB) and The Scientific and Technological Research Council of Türkiye (TÜBİTAK) for industrial companies. The ultimate purpose of these incentives is to implement and commercialize projects. These incentives are also intended to lower the costs associated with firms' R&D and innovation activities.

Techno parks and R&D centers also play a key role. Furthermore, the public, universities, and private sectors collaborate extensively to provide incentives. There are important incentives for companies operating in techno parks and R&D centers such as corporate and income tax exemptions (100%), employer share insurance premium support (50%), customs duty exemptions, basic science support, stamp duty exemptions, Value Added Tax (VAT) exemptions, R&D and design discounts (100%), and income tax withholding incentives (80-90-95%). These incentives and support mechanisms are governed by Law No. 4691 on Technology Development Zones and Law No. 5746, which regulates the support of R&D and design activities. Companies conducting R&D activities in Türkiye are subject to these regulations. Figure 7 shows how much R&D expenditure was made from 2015 to 2024, what portion of it was used as incentive, and what percentage of total R&D expenditure was covered by incentives.

Figure 7: Share of R&D Expenditures and Indirect Incentives of Financial and Non-Financial Companies, 2015-2024

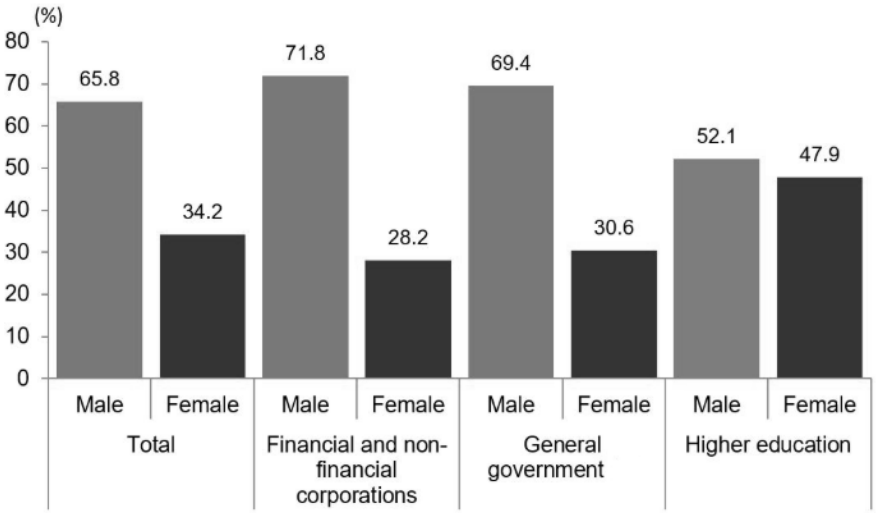


Source: *Research and Development Activities Survey, TurkStat (2025)*

In Türkiye, there was an increase in the proportion of indirect R&D incentives out of total private sector R&D spending during 2024. The proportion of indirect R&D incentives to R&D spending of financial and non-financial corporations was up from 14.8% and 11.2 billion TL in 2015 to 25.1% and 422.3 billion TL in 2024.

Data for 2024 indicate growth in the employment of qualified R&D personnel and researchers. In total, 310.473 R&D personnel were employed in Türkiye during this period. By sector, it can be noted that 67.1% of all R&D personnel are employed in financial and non-financial institutions, followed by higher education with 30%, while 2.9% are found in the general government sector which includes non-profit institutions.

Figure 8: Breakdown of R&D Personnel by Gender, 2024

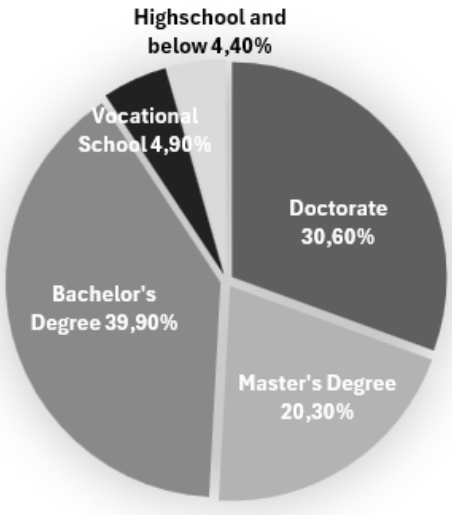


Source: *Research and Development Activities Survey, TurkStat (2025)*

Figure 8 shows the breakdown of R&D human resources by gender in 2024. As it is seen, 34.2% of the total number of full-time equivalent R&D personnel, or 106.074 personnel, were women in 2024. Looking at the sectoral distribution, the share of female R&D personnel was 47.9% in higher education, 30.6% in general government, which includes non-profit organizations, and 28.2% in financial and non-financial companies.

Finally, when the educational background of R&D personnel in 2024 is examined, which is shown in Figure 9, 39.9% of the R&D personnel have a bachelor's degree, 30.6% have a doctorate or equivalent, 20.3% have a master's degree, 4.9% have vocational school and 4.4% are from high school and below categories.

Figure 9: Number of R&D Personnel by Educational Status



Source: Research and Development Activities Survey, TurkStat (2025)

Overall, Türkiye has achieved notable progress in reinforcing its R&D ecosystem over the past decade. The steady rise in R&D expenditure, incentive mechanisms, and the number of qualified personnel indicates a clear shift toward a more innovation-oriented economic structure. Moreover, the increasing participation of the private sector, together with sustained public support, has expanded research capacity and strengthened cooperation among industry, academia, and public institutions. Collectively, these advancements support Türkiye's long-term objectives of developing domestic technologies, promoting sustainable growth, and improving international competitiveness.

2.3.The Importance of R&D

Policies centered on R&D function as a key driver of economic performance for both firms and national economies. Through R&D activities, companies can improve operational efficiency, strengthen their competitive position in markets, enhance sustainability, and develop new products. As a result, such strategic investments are widely regarded as a fundamental source of long-term growth and a critical pathway for moving up global value chains.

From a macroeconomic viewpoint, R&D expenditures make a meaningful contribution to sustainable economic development. By improving total factor productivity, R&D spending acts as a key driver of overall economic performance. In addition, it supports the dissemination of technological knowledge across sectors and contributes to the formation of a highly skilled labor force. In the endogenous growth framework proposed by Romer (1990), R&D activities are identified as a core mechanism through which knowledge is accumulated and transformed into intermediate and final goods. Within this framework, knowledge generated by R&D is embodied in intermediate inputs and subsequently reflected in final production, enabling higher levels of output. Market-based incentives further encourage firms, particularly in industrial sectors, to engage in R&D activities. This interaction creates a self-reinforcing process that underpins long-term economic growth driven by internal economic dynamics.

Empirical findings indicate that economies with relatively high R&D intensity tend to achieve stronger improvements in key macroeconomic outcomes, including GDP growth, productivity performance, and international competitiveness. According to data from the OECD, the average R&D intensity among member countries stood at approximately 2.7% in 2023. However, technology-oriented economies such as Israel and South Korea recorded substantially higher ratios, approaching 5% during the same period (OECD, 2023). Evidence from the TurkStat shows that Türkiye's R&D intensity has followed a consistent upward trend, reaching 1.46% in 2024 (TurkStat, 2025). This upward movement reflects ongoing efforts to strengthen the country's science and technology infrastructure and enhance its innovation capacity. In terms of funding structure, R&D activities are predominantly financed by the

private sector, followed by contributions from higher education institutions and non-profit organizations.

Entrepreneurs act as important drivers of economic development by introducing innovative technologies that challenge existing production and business practices. Although firms' R&D activities lie at the core of this process, the knowledge and innovations generated through R&D are not confined within organizational boundaries. Through information exchange, intersectoral linkages, and collaborative arrangements, these activities can be broadened and further strengthened. In this context, R&D plays a crucial role in shaping the foundations of national economic capacity. Moreover, by supporting export performance, R&D contributes to enhancing a country's technological autonomy, thereby transforming firm-level R&D investments into a strategic instrument for national development.

In short, by combining knowledge production, technological advancement, and entrepreneurial dynamics into a single integrated system, it benefits the entire national economy. Accordingly, R&D activities constitute a central element in economic progress at both micro and macro levels.

2.4.Objectives of R&D

R&D activities support the long-term continuity and sustainable development of firms and organizations, while also contributing to broader social welfare. Beyond enhancing firm value, these activities strengthen knowledge accumulation and thereby create the conditions necessary for future macroeconomic growth.

The key objectives of R&D activities can be summarized as follows (OECD, 2019):

•Maintaining and enhancing competitive advantages: Monitoring the innovation and growth activities of competing firms to preserve market share and strengthen competitive positioning,

•Development of new products and processes: Investigating previously unexplored products and processes, and improving existing ones to create innovative solutions,

•Discovery of innovative applications: Identifying new applications and utilization areas for existing products and technologies to enhance the firm's value-added output,

•Increasing efficiency and profitability: Improving resource utilization, reducing costs, and implementing quality-enhancing methods to raise overall profitability,

•Strengthening information and management systems: Supporting management information systems to ensure timely and reliable data for decision-making processes,

•Technology monitoring and adaptation: Continuously tracking technological trends and integrating new technologies into business processes to increase operational efficiency and maintain competitive

strength,

•Societal contribution and sustainability: Innovations produced through R&D not only develop firm performance but also elevate societal living standards, supporting sustainable progress in line with environmental and social responsibility principles.

These objectives underscore the strategic relevance of R&D at both the firm and national levels. At the enterprise level, R&D activities enable firms to improve existing production processes while also supporting the development of new products and methods that enhance market differentiation and competitive advantage. From a national perspective, investments in R&D contribute to the strengthening of the innovation ecosystem by establishing the infrastructure required for technology-driven growth and international competitiveness. In this regard, R&D activities emerge as a key instrument for promoting economic development and improving social welfare across both microeconomic and macroeconomic dimensions.

2.5.Accounting for R&D Expenditures

In Türkiye, the accounting treatment of R&D expenditures is shaped by the provisions of the Tax Procedure Law (VUK) and Turkish Accounting Standard 38 (TAS 38), which adopt different approaches. Under VUK, firms are permitted to recognize R&D expenditures directly as expenses in the income statement, while an alternative option allows these costs to be capitalized in the statement of financial position. Although this flexibility offers discretion to firms, it may reduce the comparability of financial statements across companies.

By comparison, Turkish Accounting Standard 38 (TAS 38), which is fully aligned with International Accounting Standard 38 (IAS 38), applies a more structured and transparent approach by distinguishing R&D activities into two stages: the research phase and the development phase. Expenditures incurred during the research phase are expensed, reflecting the uncertainty surrounding future economic benefits. In contrast, costs arising in the development phase may be recognized as intangible assets, provided that all conditions set out in Article 57 of TAS 38 and IAS 38 are satisfied. These conditions primarily relate to technical feasibility, the entity's intention and ability to complete, use, or sell the asset, the existence of probable future economic benefits, and the reliable measurement of related expenditures.

The implementation of TAS 38 plays a key role in Türkiye's alignment with International Financial Reporting Standards (IFRS). By promoting greater transparency, reliability, and comparability in the reporting of R&D expenditures, this standard enables investors, shareholders, and other stakeholders to evaluate corporate economic value more accurately (TAS 38, Articles 54–57; IFRS Foundation, 2023).

3.LITERATURE REVIEW

Empirical research indicating a relationship between R&D activities and firms' financial performance has increased scholarly interest in examining this linkage. A review of the existing literature shows that R&D expenditure is generally associated with various measures of firm performance. In this thesis, the literature review is structured under two main categories: empirical studies conducted in Türkiye and those carried out in international contexts. Furthermore, international studies are classified into two subgroups, distinguishing between research focusing on developed economies and studies addressing emerging economies.

3.1.Empirical Studies in Türkiye

A considerable number of empirical studies conducted in Türkiye report a positive association between R&D expenditure and firm performance, as reflected in profitability, growth, and market-based indicators.

Karacaer et al. (2009) analyzed 84 firms listed on Borsa İstanbul over the 2005–2006 period and reported a positive and statistically significant association between R&D expenditures and both stock returns and ROA. They also observe that firms engaging in R&D tend to be larger in size, more profitable, and employ a greater number of workers. Consistent findings are reported by Kotan (2011), who examines 40 manufacturing firms listed on BİST between 1995 and 2009 and finds that higher R&D intensity is linked to increases in share prices, stronger sales performance, and improved profit margins.

Along the same lines, Çiçek and Onat (2012) evaluated innovative activities among nine information and technology firms on BİST through Data Envelopment Analysis, using changes in intangible assets and R&D expenditures as inputs and changes in ROA and sales as outputs; five firms were found to be efficient, underscoring that increasing R&D and intangible-asset investments is linked to higher sales.

Kalay et al. (2013) made a regression and correlation analyses in order to relate R&D level and R&D ratio to stock returns and asset profitability, controlling for firm size and headcount for 12 technology firms listed on BİST for the year between 2005 and 2008. The findings indicate a positive influence of R&D expenditure on both equity returns and ROA.

Consistent with Karacaer (2009) and Kotan (2011) studies, Doğan and Yıldız (2013) examined 173 Turkish firms for the year between 2008 and 2011 in order to analyze that R&D expenditures influence profitability represented by ROA and ROE. They employed multiple regression and concluded that firms engaging in R&D exhibit higher profitability, and that increases in R&D are linked to gains in profitability metrics.

Ünal and Seçilmiş (2014) analyzed 29 Gaziantep firms over 2005–2010 using a dynamic panel framework to examine two links: the effect of R&D expenditure on net sales and the effect of net profit on R&D expenditures. The results indicate positive associations in both directions, with R&D expenditure raising net sales and net profit, in turn, leading to higher future R&D expenditure.

Uzun Kocamış and Güngör (2014) examined 16 BİST technology firms for the year between 2009 and 2013. They used correlation and regression analysis to evaluate the impact of R&D expenditure, which is defined as independent variables, on operating profit, pre-tax profit and net profit which are defined as dependent variables. They reported significant positive effects of R&D expenditure on all three profitability measures.

Additional empirical evidence is provided by Ayaydın and Karaaslan (2014), who examine 145 manufacturing firms listed on Borsa İstanbul over the 2008–2013 period using the Generalized Method of Moments (GMM) approach. Their findings indicate that R&D intensity has a positive and statistically significant effect on firm performance. The results further show that firm size and operational efficiency are positively associated with profitability, whereas financial leverage exerts a negative influence. Moreover, industry-level technology intensity is found to enhance firm performance, emphasizing the role of sustained investment in innovation.

Yücel and Ahmetoğulları (2015) investigated the impact of R&D investments on changes in net profit and earnings per share (EPS) among BİST listed firms in the technology, software, and IT sectors. Using stepwise regression on 135 firms over 2000–2014, they reported a pronounced upward trend in R&D investments, a positive link between shifts in R&D and shifts in net profit, and a three-period delayed impact of R&D on EPS.

Furthermore, Doğan and Yıldız (2016) examined a sample of 136 BİST-listed firms spanning 2008–2014 to probe the relationship between profitability and R&D expenditures. Their empirical approach combined multiple-regression analysis with t-tests using ROA and ROE as performance metrics. The results indicate that higher R&D expenditures are positively associated with profitability.

Alper and Aydoğan (2016) found a lagged positive effect of profitability on subsequent R&D for 20 chemical firms on BİST over 2001–2014. They implied that R&D expenditure affects financial performance significantly and positively with one year lag.

Dağlı and Ergün (2017) examined 66 manufacturing firms listed on BİST that sustained R&D investment throughout 2010-2013 applying panel-least-squares techniques with ROA as the variable and R&D outlays, leverage and firm size as regressors. Their findings indicated a significant positive link between R&D expenditures and ROA alongside a statistically significant negative link for leverage suggesting that profitability tends to rise with innovative investment but diminishes as indebtedness

grows.

Moreover, Yıldırım and Sakarya (2018) analyzed the effect of R&D expenditures on ROA and ROE for 5 companies in BİST Technology and IT sectors. They used panel data analysis for the years between 2009 and 2016. The results indicate a long-run causality between R&D outlays and both ROA and ROE, with a unidirectional causal flow running from R&D expenditures to ROA and ROE. Subsequent regression estimates show that R&D expenses have significant and positive impact on both profitability measures.

Günay, Kaygısız, and Ayar (2018) observed 5 years of data for 16 technology firms listed on BİST for the years between 2012 and 2016. They showed a persistent upward curve in R&D expenditure and found a strong positive association between R&D expenses and operating profit, pretax profit, and net profit. The study also showed that increases or decreases in R&D expenditure meaningfully translate into corresponding movements in firms' profit and loss amounts.

Demir and Güleç (2019) analyzed 60 manufacturing firms listed on BİST over the 2005–2016 period. They used a GMM system to examine the association between R&D spending and profitability. The results showed a positive and statistically significant relationship between R&D investment and profitability after controlling firm characteristics. In addition, strong balance sheet conditions and higher liquidity support profitability, while greater financial leverage weakens it.

Ayaydın et al. (2019) examined the long run link between R&D expenditures and three market based indicators for 7 firms in the BİST Technology Index using 2008 to 2018 panel data. They focused on market to book value ratio, earnings per share, and price to earnings ratio as outcomes which also considered as dependent variables. Independent variables are considered as R&D expenses, intangible assets, leverage ratio (Total debt / total assets) and R&D intensity (calculated as R&D expenses / Net sales). The estimates showed that higher R&D expenditure is positively associated with price to earnings and with earnings per share. They also found a significant and positive association between R&D and market to book value.

Sandal and Gacar (2021) examined whether innovation measured by R&D expenditures improves profitability in the automotive manufacturing sector. Using quarterly data for BİST firms from 2016 Q1 to 2020 Q4, they built two profitability models and estimate panel regressions with robust methods. The findings demonstrate a positive and statistically significant association between R&D expenditure, and ROA and ROE, suggesting that firms with higher R&D investment tend to exhibit stronger profitability. In contrast, greater financial leverage is associated with reduced profitability.

Oral and Polat (2021) analyzed the relationship between R&D outlays and firm performance for 14 companies in BİST 30 over 2009 to 2019. Using static panel data analysis, they tested the effect of R&D

on sales, net profit, and gross profit. The estimates indicated a significant and positive relationship, indicating that higher R&D outlay is linked to higher sales as well as stronger net and gross profitability.

More recent evidence aligns with these earlier findings, Turhan (2021) investigated how R&D expenditures affect financial performance for 15 BİST firms with high R&D activity over 2009 to 2020. Using panel regression, the study models market to book value, ROA, ROE, net sales growth as dependent variables, R&D intensity as the key independent variable. The results showed a statistically significant and positive association between R&D intensity and all four outcomes, indicating that higher R&D intensity is linked to stronger profitability, higher valuation, and faster sales growth.

Örgün (2022) analyzed how corporate governance affects R&D expenditures using a sample of 72 BİST firms with 645 firm year observations from 2012 to 2020. The study found a negative and significant association between board size and R&D expenditures. It also reported positive and significant links between R&D expenditures and the control variables of leverage, ROA and firm size.

Ergün (2022), studied to investigate the impact of R&D expenditures on financial performance of in Turkish aviation sector. The study estimates three regression models on annual sectoral data for 2008–2021. ROA, ROE and ROS are defined as dependent variables. R&D intensity is defined as the main predictor. Leverage, liquidity, and sector size are defined as controls. Based on a 14-year panel for the aviation industry, multiple linear regressions show that R&D intensity has a statistically significant, positive effect on sector-level financial performance. Leverage is negatively related to ROS, whereas liquidity and sector size are positively associated with performance. The findings specify that innovative investment enhances financial results in aviation, while higher indebtedness reduces profitability.

Özekenci (2023) researched 7 firms in the BIST Technology Index for the years between 2012 and 2021 to evaluate how R&D affects firm value and financial performance. The analysis employs ROA and firm value as dependent variables, while R&D expenditures, R&D intensity, financial leverage, and firm size are included as explanatory factors. The empirical findings indicate a positive and statistically significant relationship between R&D expenditures and ROA, whereas financial leverage is found to have a negative and significant effect on ROA. By contrast, no statistically meaningful relationships are identified between firm value and financial performance, firm size, or R&D intensity.

Zengin and Kurt (2024) investigate the relationship between innovative activities and profitability among manufacturing firms listed on Borsa İstanbul. Drawing on panel data from 45 firms that reported R&D expenditures over the 2008–2021 period, their analysis identifies a positive and statistically significant link between innovation-related efforts and firm profitability. The findings suggest that higher levels of innovative activity are associated with improved profit performance.

Finally, Köksal (2025) examines the relationship between R&D expenditures and firm performance by focusing on ROE, ROA, and the market-to-book ratio. The results indicate that R&D investment contributes not only to improved financial outcomes but also to enhanced market strength through innovation and technological advancement. This positive effect is particularly evident in sectors such as defense and automotive, where higher R&D intensity is associated with stronger ROA and ROE performance, as well as higher market valuation. Overall, the findings suggest that R&D investments support long-term strategic objectives and help firms establish sustainable competitive advantages.

Nevertheless, some empirical studies report contrasting evidence, indicating that R&D expenditures may also be negatively associated with firm performance under certain conditions.

Kiracı and Arsoy (2014) made research which explores correlations among R&D intensity and profitability ratios using 25 Metal Goods–Machinery firms for the period between 2007 and 2011. The results point to a significant but negative association with equity profitability and operating profitability, and negative/insignificant relations with gross margin, ROA, and net margin.

Polat and Elmas (2016) examined 13 Turkish manufacturing firms for the period between 2007 and 2015 using panel data to assess how R&D investment relates to financial performance. They reported an overall negative association between R&D expenditures and business performance. Firm-level results vary, however: some companies appear to benefit, while others are adversely affected. The authors argue that outcomes depend on whether research and development budgets are sufficient and deployed efficiently.

Moreover, Geçici et al. (2025) conducted a study to reveal the effect of R&D expenditures on the accounting-based financial performance measures of ROA, ROE and return on sales (ROS), as well as the market-based performance measure of the Tobin Q ratio. A data set composed of 658 observations covering the years 2010-2023 of 47 companies with no missing data and operating continuously out of 226 companies which are listed on the manufacturing sector of BİST was analyzed using the fixed and random effects model. The analysis revealed a statistically significant and negative effect of R&D expenditure on ROA and ROS, but no significant impact was found on ROE and the Tobin Q ratios.

There are also several studies that present mixed evidence showing that R&D spendings and financial performance vary depending on the measurement approach, firm-level characteristics, and the time horizon under consideration.

Çiftçi (2014) investigated how R&D, marketing, and G&A expenditures affect profitability across small, medium, and large manufacturing firms. Using panel data for the manufacturing sector over 1998–2009 with R&D intensity, marketing intensity, G&A intensity, and net sales as variables. The study found that R&D expenditure has no effect on profitability in small firms but a positive effect in medium and

large firms, with the impact stronger in medium-sized enterprises. Marketing expenditures exhibit a significant and positive relationship with profitability across all size classes, whereas G&A expenditures are positively significant only for big firms and not significant for small or medium companies.

Işık, Engeloğlu, and Kılınç (2016) researched the effect of R&D on profitability and sales by using panel data for the 30 manufacturing firms with the highest R&D intensity on BİST. Analysis has been made based on quarterly observations from 2008-Q1 to 2014-Q4. Estimating pooled ordinary least squares, fixed effects model, and random effects models, they found that the level of R&D expenditure is significantly and positively related to both operating profitability and net sales. By contrast, R&D intensity and the ratio of R&D to operating expenses are not significantly associated with either outcome, a pattern the authors attribute to denominator effects, since firms that allocate larger budgets to R&D often also commit substantial resources to marketing, distribution, and general administration and expand net sales, which mechanically lowers these ratios even as absolute R&D expenditures supports performance.

Demirgüneş and Üçler (2016) studied manufacturing firms on BİST over 1992-Q1 to 2013-Q3 using panel data method and cointegration methods to test whether capitalized R&D affects firm growth measured by the percentage change in sales. They found no statistically significant impact of R&D investment on growth and attribute this to the generally low level of R&D expenditures in Türkiye. By contrast, intangible assets have a significant and positive impact on growth. The authors inferred that, although not directly evident through R&D outlays, intangibles that are partly shaped by R&D, such as patents, copyrights, and organizational know-how, contribute to firm expansion.

Aytekin and Özçalık (2018) studied the link between R&D expenditures and firm performance using quarterly data for 7 companies continuously listed on Borsa İstanbul's Technology and Informatics indices (XUTEK-XBLSM) from 2011Q1 to 2018Q1. They estimate three panel models with Earnings before Interest and Taxes (EBIT), Return on Invested Capital (ROIC), Net Sales as dependent variables, and include R&D expenditure, R&D to Net Sales, R&D to Total Operating Expenses, and Market to Book value as independent variables. The results show a positive and significant association between the level of R&D expenditure and financial performance, meaning higher R&D expenses coincide with higher EBIT and Net Sales. In contrast, the ratio of R&D to Total Operating Expenses is negatively related to performance, and the Market to Book ratio is positive and significant only in the EBIT specification, while R&D intensity measured by R&D to Net Sales is not statistically significant.

İltaş and Kaya (2018) studied firms in the BIST Technology Index (XUTEK) with quarterly data from 2009 Q1 to 2015 Q4 to test the long run association between R&D expenditures and earnings per share. They apply panel unit root and cointegration tests, followed by Fully Modified Ordinary Least Squares

and Dynamic Ordinary Least Squares estimators. The results show that R&D expenditure is cointegrated with earnings per share and has a positive long-term effect on it. They also report that R&D intensity and intangible assets are cointegrated with earnings per share but have a negative long-term association.

Güzen and Başar (2019) examined 62 firms in the BIST Industrial Index for the year between 2012 and 2018. They revealed that R&D expenditure reduces operating profit in the same year, but from the second year onward it increases profitability, reflecting a time lag before benefits appear. Higher R&D intensity is linked to higher operating profit, and growth in sales revenues also supports profitability. Overall, the results point to short-term costs and medium-term gains from R&D.

Özer et al. (2019) researched 58 manufacturing firms on BİST that invested continuously in R&D during 2012 to 2017 to evaluate effects on profitability and market value. Using panel data with ROA and market to book value (P/B) as dependent variables and controlling for firm size and capital structure. The static model shows no significant R&D effect. In the dynamic specification, R&D has a significant and positive association with both profitability and market value.

Kayhan (2019) examined BIST 30 firms from 2010 to 2018 to assess how R&D affects profitability and market value using panel data methods. R&D is captured by expenditures, the R&D ratio, and R&D intensity, while performance is measured by ROA and the market to book ratio. The results showed a positive and significant association between R&D expenditures and ROA, but a negative and significant link between the R&D ratio and ROA, with no significant effect for R&D intensity on profitability.

Erdoğan and Yamaltdinova (2019) examined 62 BİST listed firms over the 2008–2017 period using panel data methods. They aimed to assess the link between R&D investment and financial performance. The results revealed an inverted U-shaped association between R&D expenditures and both ROA and ROE, with the effect being stronger for ROE. In addition, firm size has been found to enhance profitability, while financial leverage has a negative impact.

Özkan (2022) examined 25 industrial sub-sectors drawn from Türkiye's largest 500 firms over 2013 to 2019, using panel data models to test how current and lagged R&D expenditures relates to ROA, ROE, and ROS which were considered as dependent variables. Independent variables were current year's R&D intensity, one-year lagged R&D intensity, and two-year lagged R&D intensity. Control variables were size, leverage ratio, export rate, public ownership share and foreign ownership share. The results indicated that in the current year R&D expenses reduce financial performance, the effect turns positive one year later and then gradually turns negative in the long run. Robustness checks confirm these patterns. The study recommends maintaining steady R&D investment and prioritizing long-term payoffs to sustain performance gains.

Ordu and Yücel (2022) analyzed 80 manufacturing firms on BİST over 2009 to 2020 using dynamic panel methods to study how current and up to five-year lagged R&D expenses relate to earnings per share. Using year-end data, they found that a higher ratio of R&D expenditure to sales increases earnings per share in the current period. Earnings per share also shows one period persistence. They did not find evidence that lagged R&D expenses have additional effects on earnings per share.

Kulaklı (2022) evaluated how the efficiency of R&D expenditures relates to firm profitability. R&D efficiency scores were calculated with the input-oriented BCC model of Data Envelopment Analysis, and their association with profitability is tested using correlation analysis. Kulaklı, treated capitalized R&D on the statement of financial position and expensed R&D in the statement of comprehensive income as separate inputs, analyzing them independently with year-end reports for 21 manufacturing firms from 2015 to 2019. The results indicated that capitalized R&D is used more efficiently than expensed R&D, and that its efficiency scores exhibit a stronger correlation with financial ratios than the scores based on income statement R&D. It was also found that there is a positive and statistically significant association between R&D expenditure and net profit, whereas no significant relationship is observed with gross profit.

Tepeli and Mirgen (2024) studied defense firms on BİST in order to evaluate how R&D expenditures associated to financial performance by using eight models built on eight indicators which are gross profit, dividend per share, market value, market-to-book, net profit, EBIT, closing share price, and earnings per share. Liquidity ratios such as cash, current, and quick ratios considered as control variables. They found that R&D expenditure has a significant and positive impact on dividend per share and closing share price. By contrast, R&D shows no significant link with gross profit, net profit, EBIT, market value, market-to-book, or earnings per share, although meaningful relations exist among the performance indicators themselves and with the control variables.

Some empirical studies reveal no statistically significant association between R&D spendings and firm performance, suggesting that in certain contexts innovative spending may neither enhance nor deteriorate financial outcomes.

Yücel and Kurt (2003) investigated how marketing outlays and R&D expenses affect profitability using panel data for 64 large companies listed on BİST-100 (Formerly İMKB-100) firms by using the data of 2001. Treating R&D and marketing as independent variables and operating profit, net profit, and net sales as dependents, the authors found that marketing associated with net sales and operating profit in a positive way but associated with net profit in a negative way. R&D expenditures, however, show no significant effect on either profitability or sales.

Additionally, Arslantürk (2010) set his sights on a sample of 62 BİST-listed manufacturing outfits that had kept the R&D ledger ticking each year from 2004 to 2008. He fashioned two multiple-regression frameworks to probe whether the R&D line item shed any light on stock returns and the associated risk while holding size and book-to-market ratio constant. The study found no appreciable link between R&D spend and either returns or volatility. The study also maintains that R&D outlays in Türkiye during the examined period were so modest that they failed to produce any shift in equity returns or risk.

Moreover, Konak and Kendirli (2014) examined the nexus among R&D expenditures and firm performance by using the data of 10 firms listed on BİST Information Index for five years between 2009 and 2013. They found no statistically significant association, indicating that firm performance in their sample does not appear to be associated with R&D expenditures.

Furthermore, Korkmaz (2019) examined 58 manufacturing firms listed on BİST for the years between 2007 and 2016 probing how their R&D and marketing expenditures relate to financial performance. The analysis found a one -directional link from sales to R&D expenditures- higher sales appear to push firms to allocate more funds to research and development a pattern confirmed by causality testing. No causal relationship was detected between R&D and net profit ROE, ROA or the P/B ratio implying that these metrics move independently of R&D outlays, in the sample.

3.2.Empirical Studies in International Contexts

International studies were examined under two main headings: first, studies in developed economies, and finally, studies in emerging and developing economies.

3.2.1. Studies in Developed Economies

Several studies conducted in developed countries report that R&D has positive impact on firms' financial performance.

Scherer (1965) researched on 365 large U.S. companies to analyze the association between R&D, revenue and profit. The findings indicated that R&D mainly boosts sales rather than profit directly. Higher sales then support profitability, so R&D contributes to profits indirectly through its positive effect on revenue growth.

After this early evidence, Branch (1974) examined 111 U.S. firms selected from the largest 1,000 companies across seven industries in Federal Trade Commission covering the years of 1950–1965 and found that R&D activity tends to raise both profitability and growth, while prior profitability in turn stimulates subsequent R&D investment.

Later, Tassey (1983) employed capitalization of R&D to measure research activity and examined its impact on various efficiency ratios including profitability, sales and ROE. The study results that for firms operating in high-technology industries, research activity makes a significant contribution to improving these performance indicators.

Geroski and Machin (1992) analyzed 539 UK firms, and they uncovered a striking pattern: companies that devoted resources to research and development tended to expand more swiftly and capture higher profit margins than those that shunned R&D. The evidence points to a link between R&D activity and both stronger growth and improved profitability.

In the same direction, House et al. (1994) investigated the nexus between R&D outlays and profit performance surveying 26 computer software firms and 24 pharmaceutical entities from 1990 and applied a simulation methodology to describe the association. Profitability is measured by ROA and ROS, while innovation is proxied by the R&D to sales ratio and R&D per employee. In the software industry, R&D per employee is positively related to both profitability measures, but the R&D to sales ratio is not significant. In the pharmaceutical industry, both the R&D per employee measure and the R&D to sales ratio are positively and significantly associated with ROA and ROS.

Lev and Sougiannis (1996) studied on Greek listed firms that report under IFRS and they showed that operating income has a positive relationship with both current and lagged R&D expenditures, and they further showed that the timing of R&D's impact on contemporaneous operating results varies by industry, indicating sector-specific lag structures in how innovation translates into earnings.

Soon after, Lau (1998) reported that companies with greater R&D intensity tend to realize stronger advancements in revenue within the S&P 500's chemical and allied products sector. The pattern that emerges is a upward-tilted link between spending on innovation and top-line growth, in this industry implying that a stronger R&D commitment can translate into superior sales performance.

Eberhart et al. (2004) analyzed 8.313 cases for the years between 1951 and 2001. They selected firms with unexpectedly increased R&D expenditure using Compustat data. They reported significantly positive abnormal stock returns afterward, indicating initial market underreaction. They also found persistent improvements in abnormal operating performance over about 5 years. Overall, the evidence suggests that R&D increases are value enhancing and that linking R&D to profitability is most informative when future increases in R&D have been considered.

Subsequently, Chen et al. (2005) studied on 4.254 firms listed on the Taiwan Stock Exchange for the year between 1992 and 2002 using regression and correlation to link value-creation efficiency and intellectual capital to market value and financial performance. Their evidence shows that R&D intensity is positively and strongly associated with revenue growth and that R&D expenditure positively affects

firm value and profitability, indicating a clear contribution of innovative investment to both market and accounting outcomes.

Huang and Liu (2005) examined whether innovation capital and IT capital relate to firm performance in a non-linear way and whether their interaction creates synergy, using data on the top 1.000 Taiwanese companies and multiple regressions with ROA and ROS as performance measures. They found an inverted U-shaped relationship among R&D intensity and performance, while IT intensity alone was not significantly associated with performance. When the interaction between innovation capital and IT capital was included, the joint effect became positive, indicating that IT strengthens the performance gains from innovation spending.

Yeh et al. (2008) examined 301 IT and electronics companies in Taiwan for the years from 1999 to 2004 by using Taiwan Economic Journal data and a panel threshold regression to test whether there is an optimal R&D intensity to maximize financial performance. They conclude that there is a positive and significant relationship between R&D intensity and firm performance.

Anagnostopoulou and Levis (2008) analyzed 2.182 UK firms over 1990–2003 using correlation analysis with R&D intensity, gross sales, and gross profit. They find that R&D intensity is positively associated with gross profit and stable sales growth, and that high–R&D-intensity firms earn higher stock returns than their low–R&D counterparts.

Karjalainen (2008) investigated how R&D investment relates to firm profitability by using data from 14.577 companies across ten countries for the years between 1985 and 2004. The analysis discovered a positive correlation between R&D outlays and profit margins, showing that firms that channel more cash into research and development typically enjoy stronger bottom-line performance.

Artz et al. (2010) examined the effects of R&D expenditures, patents, and new product announcements on financial performance for 272 firms across 35 industries for the years between 1986 and 2004. The data of firms for this study has been drawn from Compustat North America, a database of financial information on U.S. and Canadian publicly held companies. The study applied the ordinary least squares method with R&D expenditure, patent count, firm size, ROA, and sales growth as variables. The results reveal that the number of patented inventions increases with rises in R&D expenditure, but at a diminishing rate; moreover, a significant and positive relationship was found between R&D expenditure and ROA.

Li and Hwang (2011) investigated the impact of firm size, financial leverage, and R&D expenses on profitability using 2.078 observations from 212 S&P 500 firms over 1996–2005. The independent variables are the log of total assets (size), the log of total debt/total assets (leverage), and R&D expenditure per employee, with ROE as the dependent variable. The study found a positive and

statistically significant relationship between R&D expenditure and ROE.

Çiftçi and Cready (2011) examined firms listed on the NYSE, NASDAQ and AMEX from 1975 through 2003 employing panel regressions, on data pulled from Compustat and CRSP. They investigated how R&D expenses relate to profitability and found a statistically significant and positive link. The results indicate that companies which invest more in R&D tend to report stronger profit performance.

Hajiheydari et al. (2011) examined 20 large multinational pharmaceutical firms over 2006–2010 using regression analysis to assess the profitability effects of R&D expenditure, and they also considered sales in the specification. The results indicated a positive and strong relationship between R&D expenditure and profitability and showed that increases in R&D investment are accompanied by higher sales.

Dave et al. (2013) studied 60 S&P 500 IT firms from 2001–2010 and relate R&D expenditures and R&D intensity to sales growth, gross margin, and ROA using linear regressions. They found that higher R&D is positively and significantly associated with sales, gross margins, and ROA. Gross margin appears to be the main channel linking R&D to financial sustainability (firms with stronger margins show stronger ROA). They also noted that the payoff from R&D is time-lagged and varies by firm, but, overall, greater R&D intensity supports pricing power and improves financial sustainability.

Apergis and Sorros (2014) examined the profitability effects of R&D using panel cointegration tests for 183 U.S. energy firms over 2000–2012, splitting the sample into fossil fuel (39 firms) and renewable energy (144 firms) groups. With R&D expenditure and cash flows as independent variables and ROA/ROE as dependent variables, the results show that a significant and positive long-run relationship between R&D and profitability across the sector, with the effect stronger among renewable energy firms.

Rafiq et al. (2016) examined 168 mining firms from the United States and China over 2009–2013, applying Coarsened Exact Matching to assess the impact of R&D expenditures on financial performance. Results indicate that higher R&D investment is related to deeper profit growth, and they indicate that there is a clear advantage for mining companies that intensify innovative spending. The study also found that U.S. firms demonstrate better financial performance compared to Chinese counterparts over the sample period.

Other studies present mixed evidence show that R&D spendings and financial performance vary depending on the measurement approach, firm-level characteristics, and the time horizon under consideration.

Parcharidis and Varsakelis (2007) examined 36 industrial and computer firms listed on the Athens Stock Exchange for the years between 1995 and 2000. They determined that R&D expenditure is linked to a negative effect on profitability in the same year, but a strong and positive effect emerges two years later.

Das et al. (2009) studied on Canadian firms and emphasized that the accounting treatment of R&D directly affects reported financial performance. When R&D is expensed in the period incurred, current net income falls and profitability ratios such as ROA and ROE decline. When R&D expenses are capitalized as intangible assets and deferred to future periods, the immediate impact on net income and return on equity is avoided, but the increase in total assets can depress ROA. In all cases, the economic benefits typically materialize only if the projects succeed, most clearly when they lead to patents that generate identifiable revenue or cost advantages.

Chen et al. (2013) researched how R&D expenditures and patent filings relate to financial outcomes drawing on Taiwanese high-tech firms over 2000–2011. Study identified high innovation energy firms with intensive R&D and many patents and showed that the timing gap between R&D expenditures and subsequent benefits, as well as the patent application lead time, significantly influences stock returns. These delays, together with the firm's R&D intensity, also affect net sales. Overall, high-innovation firms achieve stronger stock returns and higher sales, but not higher operating income, because elevated R&D outlays raise operating costs enough to offset income gains.

VanderPal (2015) examined firms across multiple sectors from S&P database from 1979 to 2013 using panel data and found that R&D expenses are positively associated with overall financial performance and market value. Across the sample of 103 companies, higher R&D expenses relate to stronger results in revenues, net income, equity-based measures, and ROE. The study also reports broadly positive links to sales and profitability. In some specifications, however, the contemporaneous association with operating income appears weaker or negative, which consistent with the immediate expense recognition of R&D before benefits materialize.

Usman et al. (2017) surveyed firms across the G7 from 2004 to 2006 probing how R&D expenditure relates to both company performance and market value. Firm performance was measured by ROA and cash flow from operations, while firm value was determined using Tobin's Q and market capitalization variables. The analysis controlled for firm size, age, leverage, GDP growth, interest rates, and a dummy variable representing the financial crisis. Using hierarchical linear modeling with robust standard errors, the researchers found that R&D expenditures in the same year were negatively correlated with firm performance but positively correlated with firm value. However, R&D expenditure lagged by one year and was positively correlated with both performance and value, while R&D expenditure lagged by two years and had no significant effect.

Several studies find no statistically significant relationship between R&D expenditure and firm performance.

Lööf and Heshmati (2008) investigated causality between investment indicators (R&D expenses, physical capital) and performance measures (capital structure, cash flows, sales, profit, number of employment) for Swedish firms over 1992–2000, splitting the sample into firms with 50–249 employees and those with higher than 250 employees. They find no causality between R&D and sales for the group with 50-249 employees, but a one-way causality from sales to R&D in firms with higher than 250 employees, indicating demand conditions drive subsequent R&D. In both size classes, they found that there is no causal link between R&D and profitability.

Demir and Alpaslan (2016) examined 20 global firms with the highest R&D and innovation spending for the year between 2008 and 2012, using data on net profit, equity size, employee count, and R&D expenses. Contrary to expectations, they did not find evidence that increases in R&D expenditure and innovation are associated with improvements in company performance or employment. The results show that very high R&D budgets do not automatically translate into short-term gains in profitability or headcount.

Chen and Ibhagui (2019) studied the link between R&D and firm performance using Hansen's 1999 threshold regression on 2.942 NASDAQ firms from 2002 to 2017. The dependent variables are Tobin Q, ROA, ROE, and net income growth, the main independent variable is R&D intensity, and the controls are assets, leverage, marketing intensity, and operating capacity. The results confirm threshold effects and reject a simple linear relation. In particular, R&D is associated with better performance when R&D intensity is below the estimated threshold, indicating gains at lower R&D levels and a nonlinear pattern overall.

3.2.2. Studies in Emerging and Developing Economies

There are several studies document that R&D is positively linked to firm performance.

Zhu and Huang (2012) empirically tested the relationship between R&D intensity and one-year financial performance by using the annual data of 106 Information Technology companies in China for the years between 2007 and 2009. In their analysis R&D intensity served as the independent variable and it was measured as the ratio of a firm's R&D expenditure to its revenue. The model's primary dependent variable was ROA lagged by one year. The analysis revealed that IT companies allocate more resources to R&D than other high-tech manufacturers and that a higher R&D intensity is positively and significantly linked to better financial performance a year later meaning the stronger R&D effort translates into stronger results, in the following years.

In the same year**,** Sharma (2012) analyzed the effect of R&D expenditures on the financial performance of firms listed in the pharmaceutical sector in India between 1994 and 2006 and revealed a positive relationship between R&D expenditures and financial performance.

Rabiei and Dadkhah (2014) examined Iran's two-digit ISIC manufacturing industries between 2001 and 2009 using panel data to assess the returns on R&D investment. Their results show that R&D expenditure has a statistically significant positive effect on profitability, marking innovative outlays as a key profit driver in the sector. The study also points advertising expenditure and the level of market concentration, as factors that influence profitability.

Freihat and Kanakriyah (2017) set out to investigate how R&D shapes the outcomes of pharmaceutical firms listed on the Amman Stock Exchange. They focused on six companies applying linear regression to capture R&D intensity over the 2006-2010 and then examined performance, which were measured by ROE, ROA and earnings per share, during the subsequent 2011-2015 period. The analysis revealed that R&D exerted a statistically significant and positive impact on each of the three financial indicators.

Tung and Binh (2021) investigated 343 listed companies on Vietnam for the years between 2010 and 2018 by using panel methods, specifically fixed effects and two stage least squares. They found that greater R&D investment is positively related to profit, revenue, ROA and ROE. The results also showed that companies with higher R&D expenditures are better than those with lower R&D in terms of revenue, profit, and ROA.

Rahman and Howlader (2022) researched 22 pharmaceutical companies listed on Dhaka Stock Exchange. They used data from the years between 2015 and 2019 and performed pooled ordinary least squares with multiple controls. They assessed financial performance by ROA and ROE, and market performance by Tobin's Q and market capitalization. The outcome showed a significant positive association between R&D outlays and both firm value and firm performance.

Sharda (2022) conducted a study of 368 Indian listed firms covering the years 2011 to 2021. The analysis incorporated ROE, R&D intensity, Tobin's Q, size, leverage and firm age as the variables. The results indicate that older firms tend to devote resources to R&D while larger firms and those with higher leverage generally invest less. Moreover, the study found a pattern: higher R&D intensity is linked to stronger financial performance, yet it is associated with a lower market valuation.

A study points to a negative association between R&D and firm performance stated below:

Pantagakis et al. (2012) investigated 39 European computer software and hardware firms over 2006–2020 using panel data and feasible generalized least squares to study how R&D relates to market value and firm performance. Market value and ROA are the dependent variables, R&D intensity is the main

explanatory variable, and leverage, firm size, and sales growth are control variables. The results show a positive link between R&D and market value, but a negative association with ROA, likely due to time lags in realizing returns.

Several studies present mixed evidence on the R&D–performance relationship, showing that the effects of innovation differ across performance measures, time horizons, and firm-specific conditions.

Schimke and Brenner (2014), showed that R&D investment generally promotes short-term turnover growth, while tangible capital outlays relate to growth in mixed ways (positive or negative) by using the European Industrial R&D Investment Scoreboard (1.000 firms). The effects of timing and strength depend on firm size, industry, and whether investments are one-off or constant, underlying a clear temporal structure in how R&D translates into sales growth.

Serhan et al. (2017) investigated how the accounting treatment of R&D - whether expensed away or capitalized - relates to firm performance using a stratified sample of 105 listed companies in Sri Lanka that are active in R&D and running multivariate analyses across a range of financial metrics. They reported that expensed R&D is positively linked to the dividend-cover ratio and at the time negatively linked to earnings per share with both relationships sizable in magnitude. By contrast capitalized R&D shows a negative association with ROA, return on capital employed and earnings per share. For the rest of the indicators both expensed and capitalized R&D display only weak or no meaningful relationships.

Subsequently, Huang (2020) analyzed 107 listed healthcare firms in China over 2016–2018. The study processes regressions of R&D expenditures on financial performance by using SPSS. Short-term performance is summarized with principal component analysis that combines indicators of profitability, operating capacity, and growth, while long-term performance is measured by Tobin's Q. The results show a trade-off: higher R&D intensity is associated with lower short-term financial performance but higher long-term financial performance.

Ali et al. (2025) analyzed 51 listed companies on Pakistan Stock Exchange for the year between 2005 and 2021. They measured performance with ROA and Tobin's Q and documented a clear intertemporal trade off: higher R&D intensity depresses short-term profitability captured by ROA, yet raises long-term market value reflected in Tobin's Q. The study shows that larger firm size increases the positive effect of R&D, whereas greater financial leverage undermines both operating and market outcomes.

As highlighted above, while some studies report positive effects and some negative, several studies which will be summarized below find no significant relationship between R&D and firm performance.

Choi and Williams (2013) analyzed 90 firms in China and Korea over 2000–2003, using annual sales growth and ROA as performance measures and R&D intensity and patent intensity (patent applications

relative to sales) as innovation proxies. Ordinary least squares results show no significant effect of R&D intensity on sales growth or ROA, whereas patent intensity exerts a statistically significant positive impact on firm performance in both countries.

Bayazidi et al. (2016) analyzed 27 pharmaceutical firms listed on the Tehran Stock Exchange for the years between 2001 and 2013 using panel data, with ROA as the dependent variable and R&D expenses, marketing expenses, capital-to-asset ratio, and number of fixed/variable employees as independent variables. The results indicate no significant relationship between either R&D or marketing outlays and profitability in Iran's pharmaceutical sector.

Taveira, Gonçalves, and Freguglia (2019) researched data on more than 10.000 Brazilian industrial companies over 2001–2008 in order to test the association between innovation and profit. Using R&D expenditure as an input measure and the stock of technical–scientific personnel as an effort proxy, they find that a larger technical–scientific workforce raises the likelihood of innovating, whereas R&D outlays show no effect. Moreover, innovation does not translate into higher profits in this sample, indicating a weak connection between innovative efforts and firm performance in the Brazilian context.

Intrisano et al. (2024) examined European listed firms to test whether innovation relates to financial performance using 2020 data for 224 companies from the Amadeus Bureau van Dijk database. Innovation is proxied by R&D expenses divided by sales, and financial performance is measured by ROE, ROCE, EBITDA margin, profit margin, and ROA. Pearson correlations with these metrics are small and positive, roughly between 0.016 and 0.034, but none are statistically significant at the five percent level, which indicates no immediate same-year association. They argued that R&D may influence results over a longer horizon due to lagged effects.

4.RESEARCH DESIGN

This section presents the research design adopted in the study. It introduces the dataset employed for the empirical analysis, specifies the variables incorporated into the models, and outlines the hypotheses formulated to investigate the relationship between R&D activities and firm performance. Furthermore, the methodological approach used to test these hypotheses is described in a systematic and detailed manner.

4.1.Dataset

The dataset comprises non-financial firms operating in manufacturing sector and listed on Borsa İstanbul for the year between 2013 and 2022. In the initial phase, a total of 113 firms listed on BİST with R&D expenditures in 2013 were identified. To ensure the reliability of the dataset, only firms with continuous R&D expenditure over a ten-year period were selected. 37 firms that lacked R&D expenditures in certain interim years were excluded from the dataset. Since the study focuses on non-financial firms listed on BİST, one company operating in the financial sector was also excluded. Finally, 9 more firms that caused extreme values were also excluded from the analysis. In total, 47 firms were excluded, leaving a final sample of 66 firms whose annual data for ten-year period including 660 observations were obtained from the financial statements provided by the Public Disclosure Platform (PDP). Data for the years between 2023 and 2024 were not included in the dataset to eliminate the impact of inflation accounting practice, which started to be implemented in Türkiye as of the end of 2023, on the analysis.

Grabowski and Mueller (1978) demonstrated that R&D investments in companies operating within research-intensive sectors are highly efficient. Moreover, they concluded that the variability in the future profitability of these firms is reduced by half when R&D investments are capitalized as assets rather than recorded as expenses in the income statement. To eliminate this limitation and more accurately represent the total R&D expenditure of each firm, both expensed and capitalized R&D amounts were combined in the calculations by capturing the effects that appear in both the statement of profit or loss and the statement of financial position. Accordingly, in addition to the R&D expenses reported in the income statement, capitalized R&D amounts were extracted manually from the notes to the financial statements, as these figures are not directly visible in the statement of financial position. In addition, since capitalized R&D is included in the analysis, the depreciation and amortization expenses under R&D expenses in the statement of comprehensive income, which are obtained from the footnotes, excluded from the analysis in order to avoid including the effects of capitalized R&D a second time. It

was also observed that the firms used various labels to show these capitalized R&D in the notes on intangible assets, such as “Development Costs”, “Development Expenses”, “Capitalized Development Costs”, “Research and Development Expenses”, “Capitalized R&D Projects” and “Investments in Development Activities”.

4.2.Variables

The independent variables include the ratio of R&D expenditures (Expensed R&D and Capitalized R&D) to net sales which is defined as R&D Intensity in the thesis, and one-year lagged R&D Intensity, while the dependent variables are return on assets (ROA) and return on equity (ROE). Additionally, firm size, leverage, and liquidity are used as control variables.

4.2.1.Dependent Variables

The firm’s financial performance is evaluated with ROA and ROE to assess how R&D investments contribute to firms’ strategic and financial success. ROA, an accounting measure of corporate performance, has seen broad adoption in the literature (e.g., House et al., 1994; Gedajlovic and Shapiro, 1998; Anderson et al. 2000; Tosi et al. 2000; Huang & Lui, 2005; Karacaer, et al., 2009; Das et al., 2009; Artz et al., 2010; Zhu and Huang, 2012; Pantagakis et al., 2012; Dave et al., 2013; Choi and Williams, 2013; Apergis and Sorros, 2014; Polat and Elmas, 2016; Bayazidi et al., 2016; Doğan and Yıldız, 2016; Bouaziz, 2016; Freihat and Kanakriyah, 2017; Chen and Ibhagui, 2019; Kayhan, 2019; Korkmaz, 2019; Erdoğan and Yamaltdinova, 2019; Sandal and Gacar, 2021; ; Turhan, 2021; Özkan, 2022; Rahman and Howlader, 2022; Özekenci, 2023; Zengin and Kurt, 2024; Intrisano et al., 2024; Köksal, 2025) is calculated as net income to total assets (Firer and Williams, 2003; Maditinos et al, 2011; Restuti et al., 2018; Buallay et al., 2019; Soetanto and Liem, 2019; Yao et al., 2019; Xu and Wang, 2019; Xu and Li, 2020). It is a financial ratio that shows the proportion of profit a company earns to its total assets. The ratio is commonly used to compare companies within the same industry, since some industries are more asset-intensive, requiring expensive equipment to generate income, than others. It is therefore normal for asset-intensive companies to have lower ROA than firms in less asset-intensive sectors. An increasing trend in ROA indicates improving profitability, whereas a descending trend signals deterioration (Kabajeh et al., 2012).

Brigham and Besley (2008) describe ROE as an indicator of how effectively a firm uses shareholders’ funds to generate profit. Similarly, Zutter and Gitman (2012) define ROE as the financial ratio capturing the return earned on the value of shareholders’ equity, which comprises proceeds from issued shares plus retained earnings. As a core profitability metric, a higher ROE signals that the firm is more efficient at generating income from each unit of equity. Computed as net profit divided by total shareholders’

equity, ROE reflects the earnings generated on owners invested capital and thus helps investors compare firms' performance. Lower ROE values indicate weaker use of equity, whereas higher values point to more effective deployment of the company's resources. It a financial performance proxy commonly used in literature (Das et al. 2009; Li and Hwang, 2011; Zhu and Huang, 2012; Apergis and Sorros, 2014; VanderPal, 2015; Doğan and Yıldız, 2016; Bouaziz, 2016; Freihat and Kanakriyah, 2017; Chen and Ibhagui, 2019; Korkmaz, 2019; Sandal and Gacar, 2021; Turhan, 2021; Özkan, 2022; Sharda, 2022; Rahman and Howlader, 2022; Intrisano et al., 2024).

4.2.2.Independent Variables

The independent variables of the study are R&D intensity (RDI) and one-year lagged R&D intensity. R&D encompasses expenditure directed toward developing new products or services and addressing current or future technical problems. In this study, R&D intensity is computed as R&D expenditure divided by net sales, a formulation commonly adopted in the literature (Branch, 1974; Huang and Liu, 2005; Pantagakis et al., 2012; Freihat and Kanakriyah, 2017; Erdoğan and Yamaltdinova, 2019).

Some studies have shown that R&D investments require an adaptation period before they reduce production costs and begin to generate profits. Therefore, because firm performance generally tends to improve with a time lag, the effects of investment are often not evident in the first year of the investment. For this reason, the one-year lagged R&D Intensity (Chen et al., 2019) was also included as an independent variable in empirical models.

4.2.3.Control Variables

In empirical research on firm performance, it is important to account for firm-level characteristics that may systematically shape financial outcomes. Differences in firm size, capital structure, and short-term financial conditions can influence profitability independently of innovative activities. For this reason, the present study includes firm size, leverage, and liquidity as control variables in order to isolate the impact of R&D investments on financial performance and to enhance the reliability and robustness of the estimation results.

Firm size is commonly regarded as an important determinant of financial performance, as larger firms are more likely to benefit from economies of scale, stronger market power, easier access to capital markets, and greater operational diversification. These advantages often translate into lower average costs, higher operational efficiency, and improved profitability. In line with this perspective, a broad range of empirical studies, including those by Finkelstein and Boyd (1998), Restuti et al. (2018), Tran and Vo (2018), Soetanto and Liem (2019), Karacaer et al. (2009), Zeghal and Maaloul (2010), Zhu and

Huang (2012), as well as Ayaydın and Karaaslan (2014) report a positive and statistically significant association between firm size and financial performance. From this standpoint, larger asset bases signal stronger financial capacity, allowing firms to enhance competitiveness and achieve superior business outcomes. In the present study, firm size is proxied by the natural logarithm of total assets, following the approach adopted by Öner (2016) and Nguyen et al. (2024).

Leverage measures the degree to which a company's assets are financed by debt and can influence financial performance. High leverage might increase the financial risks and cost of interest in the company, which could lower its profitability. However, high use of debt can be hazardous to the financial flexibility of a company because it might impair its solvency position. This can finally result in decreased firm performances. In empirical studies, the effect of leverage has been measured by the ratio of total debt to total assets (Karjalainen, 2008; Li and Hwang, 2011; Zhu and Huang, 2012). In this thesis, leverage has been used as a control variable that reflects the effect of leverage on firm performance. Following this approach, leverage is measured as the ratio of total debt to total assets in this thesis and is included as a control variable to capture its effect on firm performance. The implication of leverage on firm performances has been examined in various studies such as Firer and Williams (2003), Pantagakis et al. (2012), Dağlı and Ergün (2017), Usman et al. (2017), Dzenopoljac et al. (2017), Chen and Ibhagui (2019), Ayaydın et al. (2019), Xu and Li (2020) and Sharda (2022).

Liquidity is a frequently employed control variable in empirical research on firm performance, as documented in prior studies (e.g., Raheman and Nasr, 2007; Enqvist et al., 2014; Öner, 2016; Nguyen et al., 2024). The continuity of a firm’s operations largely depends on the effective management of working capital. Achieving an appropriate balance between liquidity and profitability is therefore essential, as excessive working capital may depress returns, whereas insufficient levels can give rise to liquidity constraints. Earlier research highlights the importance of maintaining this balance (e.g., Padachi, 2006; Arunkumar and Radharamanan, 2011). While certain mismatches between assets and liabilities may temporarily enhance profitability, such outcomes are often achieved at the cost of solvency. Similarly, higher returns can be realized by sacrificing liquidity, increasing financial risk. Accordingly, prudent working capital management plays a critical role in supporting firm sustainability, growth, and value creation. In line with the existing literature, liquidity is included in this study as a control variable and is measured by the ratio of current assets to current liabilities.

4.3.Hypothesis Development

The link between R&D intensity and firms' financial performance has been widely examined in empirical literature. A large body of research suggests that R&D expenditures represent a key driver of firm competitiveness and long-term profitability by stimulating innovation, enhancing operational efficiency, and facilitating product differentiation. Firms that maintain continuous investment in R&D tend to experience more stable revenue growth and stronger profitability, as accumulated innovative capabilities contribute to improved performance over time.

In Türkiye, empirical research has mostly demonstrated that R&D expenditures contribute positively to financial performance. For instance, Yücel and Kurt (2003) examined firms listed on BİST and found that R&D and marketing expenditures were associated with improved operational profitability. Similarly, Ayaydın and Karaaslan (2014) reported that R&D intensity significantly enhances firm profitability and efficiency indicators such as ROA and ROE. Uzun Kocamış and Güngör (2014) also found a strong and positive association between R&D investments and various profitability metrics among technology firms. Yücel and Ahmetoğulları (2015) documented that increases in R&D spending led to subsequent improvements in earnings per share. More recent studies also confirm this pattern. Turhan (2021) reported that higher R&D intensity positively influences profitability, market value, and sales growth among firms listed on Borsa Istanbul. Similarly, Ergün and Dağlı (2022) identified a statistically significant and positive impact of R&D expenditures on financial performance in the Turkish aviation industry. Additionally, Özkan (2022) and Zengin and Kurt (2024) documented that innovative activities and R&D investments are major drivers of profitability and value creation in the manufacturing sector on Borsa İstanbul. Collectively, these findings indicate that R&D efforts in the Turkish context not only strengthen firms' operational capabilities but also enhance their overall financial outcomes.

International evidence also supports the existence of a positive link between R&D intensity and firm performance. Scherer (1965), one of the early contributors to this field, found that R&D investments boost sales, which in turn reinforces profitability. Tassey (1983) demonstrated that R&D expenditures contribute to efficiency and long-term growth in high-technology industries. Lev and Sougiannis (1996) confirmed a statistically significant and positive relationship between both current and lagged R&D spending and operating income, highlighting the long-term impact of innovation on profitability. Later, Eberhart et al. (2004) and Apergis and Sorros (2014) emphasized that sustained R&D investment enhances firm value and leads to superior long-run financial results. More recent research further supports this positive relationship while also acknowledging that the effect of R&D on performance often emerges with a time lag, reflecting the delayed nature of innovation payoffs (Huang, 2020; Sharda, 2022; and Ali et al., 2025).

Drawing on both domestic and international empirical evidence, the prevailing findings suggest that firms with higher R&D intensity are more likely to achieve stronger financial performance over the long run. This outcome can be attributed to the role of R&D expenditures in generating intangible assets, stimulating product innovation, and enhancing technological capabilities, which together reinforce firm profitability and competitiveness. In line with this reasoning, the hypothesis examining the relationship between R&D investment and firm performance is formulated as follows:

H: R&D Intensity has a positive relationship with financial performance of firms.

4.4.Methodology

Empirical research generally relies on three main data structures: time series, cross-sectional data, and panel data, which combine both time and cross-sectional dimensions. Among these approaches, panel data analysis offers important advantages, particularly in the examination of economic relationships. Time series data allows researchers to analyze changes in a specific variable over time and are typically collected at regular intervals such as daily, monthly, or annual frequencies to identify trends and fluctuations. Cross-sectional data, by contrast, consists of observations obtained from multiple units such as individuals or firms within a single time period and enable comparative analysis across these units.

Panel data integrates the characteristics of both time series and cross-sectional data by observing the same units over multiple periods. This structure makes it possible to examine both temporal dynamics and differences across units simultaneously. As noted by Baltagi (2001), panel datasets are formed by repeatedly observing the same cross-sectional units over time, thereby incorporating both dimensions into a single framework. Similarly, Wooldridge (2003) emphasizes that this dual structure enhances the explanatory power of empirical models. Panel data techniques allow researchers to control unobserved heterogeneity across firms and generally produce more robust and reliable estimation results than traditional analytical methods.

In line with this framework, the present thesis adopts a quantitative research design that focuses on measurable financial indicators to examine the relationship between innovative activities and firm performance. Regression analysis is employed to assess the effects of one or more independent variables on multiple dependent variables, enabling a systematic evaluation of the proposed empirical relationships.

Models 1 and 2 were considered to understand the impact of R&D intensity on firms' financial performances represented by ROA, while models 3 and 4 were designed to further examine the impact of R&D intensity on firms' financial performance represented by ROE. The functional representations of these models are presented below:

$$ROA_{i,t} = \alpha + \beta_1 RDI_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 LIQ_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$ROA_{i,t} = \alpha + \beta_1 RDI_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 LIQ_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$ROE_{i,t} = \alpha + \beta_1 RDI_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 LIQ_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$ROE_{i,t} = \alpha + \beta_1 RDI_{i,t-1} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 LIQ_{i,t} + \varepsilon_{i,t} \quad (4)$$

The subscript i in the equations represents the unit dimension of the panel data and includes 66 firms (i=1,2,…,66). The subscript t represents the time dimension of the panel data and includes 10 annual observations between 2013 and 2022. The α expressions in the equations represent the panel regression constant terms, and the ε expressions represent the error terms. The Ln expression in front of the SIZE variable represents the natural logarithm of the variable. While Equation 2 is similar to Equation 1, the one-period lagged value of the R&D variable (t-1) is used in Equation 2 to model the dynamic effects. Similarly, Model 3 and Model 4, on which the ROE variable is dependent, differ in terms of the lagged value of the R&D variable. The definitions of the variables in the research models are as in Table 8.

All variables, along with their abbreviations and operational definitions, are reported in Table 8 below.

Table 8: List of Variables with their Definitions and Abbreviations

Variable	Abbreviation	Definition
Dependent Variables		
1. Return on assets	ROA	Net Income / Total Assets
2. Return on equity	ROE	Net Income / Total Equity
Independent Variables		
1. R&D Intensity	RDI	(Expensed R&D + Capitalized R&D)
2. One Year Lagged R&D Intensity	RDI_{t-1}	/ Net Sales
Control Variables		
1. Size	SIZE	Natural Logarithm of Total Assets
2. Leverage	LEV	Total Debt / Total Assets
3. Liquidity	LIQ	Current Assets / Current Liabilities

Using the variables defined above, panel data methodology has been used in estimating the research models. Panel data has different estimation methods based on the number of observations in the unit and time dimensions (Woolridge, 2010). Panel data models in which the unit dimension contains more observations than the time dimension are called short panel data models. It is known that the number of

observations in the time dimension in short panel data models generally has the characteristics of a small sample. While small sample characteristics in the time dimension make panel time series analyses difficult, they also do not pose the risk of spurious regression due to non-stationarity that may arise in the time dimension (Baltagi, 2021).

In this study, considering that the unit size consisted of 66 firms and the time dimension consisted of a 10-year period, the necessary specification tests were conducted, and analyses were conducted within the framework of Pooled Least Squares, which is suitable for short panel data models, and one- or two-way (unit and time effects) Fixed Effect Models and Random Effect Models (Çekiç & Gültekin, 2019).

The panel data model can be expressed as in Equation 5.

$$Y_{i,t} = \mu + \beta X'_{i,t} + \alpha_{i,t} + \varepsilon_{i,t} \quad (5)$$

$X_{i,t}$ in Equation 5 represents the K-dimensional vector of independent variables. The term μ represents the constant term indicating that all units have a common mean value. The term $\alpha_{i,t}$ represents heterogeneity and/or unit effect. The four possible cases for $\alpha_{i,t}$ are as follows:

1. $\alpha_{i,t} = 0$
2. $\alpha_{i,t} = \alpha_i$
3. $\alpha_{i,t} = \gamma_t$
4. $\alpha_{i,t} = \alpha_i + \gamma_t$

As seen in four different forms, panel data models can differ according to time and/or units. If the parameter $\alpha_{i,t}$ varies only by units or by time, as in cases 2 and 3, one-way panel data models can be considered. If it varies by both units and time, as in case 4, well-directed panel data models can be considered. In case 1, it can be said that there is no unit effect (Çekiç & Gültekin, 2019).

If $\alpha_{i,t} = 0$ in the panel data model in Equation 5, in other words, there is no unit effect in the model, there is only a constant term along with the explanatory variables in the model, and if the constant term in question is the same for all units, it is known that the estimation of the model with the Least Squares Method is effective and consistent.

If the forms $\alpha_{i,t} = \alpha_i$, $\alpha_{i,t} = \gamma_t$ ve $\alpha_{i,t} = \alpha_i + \gamma_t$ are present in the model in Equation 5, the pooled least squares method loses its consistency. In this case, it is possible that $\alpha_{i,t}$ contains unobservable and non-random effects. If $\alpha_{i,t}$ contains unobservable and non-random effects, the model is called a fixed effects model. For the one-way fixed effects model, the notation in Equation 6 can be used (Çekiç & Gültekin, 2019).

$$Y_{i,t} = \mu + \beta X'_{i,t} + \alpha_i + \varepsilon_{i,t} \quad (6)$$

In this notation, α_i represents the unit-specific constant terms. In the fixed effects model, the parameter $\alpha_{i,t}$ is a non-random fixed variable. There are two different situations in defining the parameter.
If $\alpha_{i,t}$ is unobservable and correlated with $X_{i,t}$, the Ordinary Least Squares (OLS) estimators will be inconsistent and biased. In such a case, the model is written in the form of a one-way error component and then estimated using the OLS method. Within-group means are then calculated, and the fixed unit effect is removed from the model using the difference α method. This process is called the within-group estimation method.

If it is assumed that $\mathrm{Cov}(X_{i,t}, \varepsilon_{i,t}) = 0$ in equation 6, the within-group average can be expressed as in equation 7.

$$\overline{Y_i} = \alpha_i + \beta\overline{X_i} + \overline{\varepsilon_i} \tag{7}$$

The following definitions are made in Equation 7.

$$\overline{Y_i} = \frac{\sum_t Y_{i,t}}{T} \quad \overline{X_i} = \frac{\sum_t X_{i,t}}{T} \quad \text{ve} \quad \overline{\varepsilon_i} = \frac{\sum_t \varepsilon_{i,t}}{T}$$

Equality 8 is obtained by taking the difference between equality 6 and equality 7.

$$Y_{i,t} - \overline{Y}_{i,t} = +\beta(X_{i,t} - \overline{X}_{i,t}) + (\varepsilon_{i,t} - \overline{\varepsilon}_{i,t}) \tag{8}$$

The OLS estimator in Equation 8 is known to be efficient and consistent. For the two-way fixed effects model, within-group transformations are performed for both unit and time effects. Therefore, the two-way model expressed in case 4 is expressed as in Equation 9.

$$Y_{i,t} = \mu + \alpha_i + \gamma_t + X'_{i,t}\beta + \varepsilon_{i,t} \tag{9}$$

Similar to the one-way fixed effects model, the two-way fixed effects model includes both unit and time effects. These fixed effects are removed through within transformations, and the regression models are then estimated using the OLS estimator.

In the random effects model, the parameters are treated as part of the stochastic process. In other words, they are defined as $\alpha_i \sim IID(0, \sigma_\alpha^2)$ and $\gamma_t \sim IID(0, \sigma_\gamma^2)$ represents the unit-specific random effects, while α_i represents the time-specific random effects. The random effects model is expressed as in Equation 10 (Çekiç & Gültekin, 2019).

$$Y_{i,t} = \mu + \beta X'_{i,t} + u_{i,t} \tag{10}$$

In the random effects model, $\alpha_{i,t}$ is assumed to be included in the error term $u_{i,t}$ due to its random effects. In other words, unit and/or time effects are considered as components of the error term. In this case, the error term can be defined as in Equation 11.

$$u_{i,t} = \alpha_{i,t} + \varepsilon_{i,t} \tag{11}$$

For the random effects model, the OLS estimators are unbiased and unefficient. Therefore, the random effects model is estimated using the Generalized Least Squares (GLS) method. Fomulas for the case with unit-specific random effects is $E(u_{i,t}) = 0$ and $Var(u_{i,t}) = \sigma_\alpha^2 + \sigma_\varepsilon^2$. More precisely, the mean of the error terms will be zero and their variance will be equal to the sum of the unit effect variance and the error term variance. In this case, the variance is constant, and therefore the combined error term will be homogeneous for all units and time, but the error terms are correlated along the time axis. In this case, the error covariance is defined as in Equation 12.

$$Cov(u_{i,t}, u_{j,s}) = \begin{cases} \sigma_\alpha^2 + \sigma_\varepsilon^2, & i = j, t = s \\ \sigma_\alpha^2, & i = j, t \neq s \\ 0, & d.d \end{cases} \tag{12}$$

For the GLS method, the model in equation 13 is obtained by subtracting the weighted within-group means from equation 10.

$$(Y_{i,t} - \overline{\theta Y_i}) = (1-\theta)\mu + \beta(X_{i,t} - \theta \overline{X}_i) + ((1-\theta)\alpha_i + (\varepsilon_{i,t} - \theta \overline{\varepsilon}_i) \tag{13}$$

Here, θ is calculated as in equation 14.

$$\theta = 1 - \sqrt{\frac{\sigma_u^2}{\sigma_u^2 + T\sigma_\alpha^2}} \tag{14}$$

For the two-way random effects model with unit and time effects, the error term in equation 11 is defined as in equation 15.

$$u_{i,t} = \alpha_i + \gamma_t + \varepsilon_{i,t} \tag{15}$$

It is important to identify unit and/or time effects and determine which of the four scenarios the panel data regression is most suitable to select between panel data estimators. In this context, considering

possible two-way effects, the first stage tested unit and time effects with the LR test (Çınar, 2021, p. 298). Since the unit and time effects were statistically significant for all four models within the scope of the study, unit and time effects were tested separately with the LR test (Çınar, 2021, pp. 299-301). As a result of these tests, it was determined that all four models were two-way models containing unit and time effects.

Haussman Tests were conducted to select the appropriate estimator for the estimation of these effects in the research models to identify unit and time effects (Tatoğlu, 2012, pp. 179-183). Based on the Haussman tests, it was found that the fixed effects estimator was valid for models 1, 3, and 4, and the random effects estimator was valid for model 2.

Cross-sectional dependencies for models 1, 3, and 4, where the fixed effects estimator was valid, were examined using the Friedman test (Tatoğlu, 2012, p. 218). Autocorrelations in these models were examined using the Modified Durbin Watson and Baltagi Wu LBI statistics. The valid heteroscedasticity problem of the fixed effects estimator was examined using the Modified Wald test. While cross-sectional dependency was not observed in the models, autocorrelation and heteroscedasticity problems were observed, and efficiency losses were prevented by estimating robust standard errors as suggested by Huber (1967), Eicker (1967), and White (1980).

For Model 2, where the random effects estimator is valid, cross-sectional dependencies were tested using the Friedman test. Heteroscedasticity in this model was examined using the Levene-Brown and Forsythe tests. Autocorrelation was examined using the Lagrange multiplier test. Similarly, cross-sectional dependence was not observed in Model 2. Furthermore, due to the identified autocorrelation and heteroscedasticity problems, robust standard errors were used by Huber, Eicker, and White to prevent efficiency losses (Huber, 1967; Eicker, 1967; White, 1980).

5.EMPIRICAL FINDINGS

An examination of the basic characteristics of the dataset is necessary prior to the regression analysis. Descriptive statistics are used to summarize the main distributional features of the dependent and independent variables and to provide information on their central tendencies, dispersion, and observed ranges. This initial evaluation allows potential outliers to be identified and helps assess whether the variables display reasonable distributional behavior, which is important for the credibility of the econometric results. Accordingly, Table 9 reports descriptive statistics for all variables included in the analysis, namely profitability indicators such as ROA and ROE, R&D intensity, firm size, leverage, and liquidity ratios for 66 firms listed on Borsa İstanbul over the 2013 to 2022 period.

Table 9: Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ROA	660	0.07625	0.08686	-0.21118	0.43309
ROE	660	0.15643	0.21601	-1.00995	1.43006
RDI	660	0.01449	0.02378	0.00000	0.14208
SIZE	660	21.40535	1.89577	17.40268	28.09009
LEV	660	0.53987	0.21505	0.07471	0.95905
LIQ	660	2.17295	2.15411	0.21490	17.40496

The descriptive statistics indicate noticeable variation across the performance and control variables. The return on assets (ROA) ranges from -0.21118 to 0.43309, with an average value of 0.07625 and a standard deviation of 0.08686. Similarly, return on equity (ROE) exhibits a wider distribution, taking values between -1.00995 and 1.43006, while its mean and standard deviation are 0.15643 and 0.21601, respectively.

R&D intensity displays relatively limited dispersion, varying between 0 and 0.14208, with a mean of 0.01449 and a standard deviation of 0.02378. Firm size (SIZE), measured in logarithmic terms, shows greater variability, ranging from 17.40268 to 28.09009, with an average of 21.40535 and a standard deviation of 1.89577. Financial leverage (LEV) also varies substantially across firms, with observed values between 0.07471 and 0.95905, a mean of 0.53987, and a standard deviation of 0.21505. Finally, liquidity (LIQ) demonstrates considerable dispersion, ranging from 0.2149 to 17.40496, with a mean of 2.17295 and a standard deviation of 2.15411.

The correlation matrix between the variables is as shown in Table 10.

Table 10: Correlation Matrix

	ROA	ROE	RDI	SIZE	LEV	LIQ
ROA	1.000					
ROE	0.756***	1.000				
	[0.000]					
RDI	0.203***	0.124***	1.000			
	[0.000]	[0.002]				
SIZE	0.149***	0.275***	0.069*	1.000		
	[0.000]	[0.000]	[0.075]			
LEV	-0.508***	-0.092**	-0.149***	0.199***	1.000	
	[0.000]	[0.018]	[0.000]	[0.000]		
LIQ	0.449***	0.113***	0.398***	-0.027	-0.674***	1.000
	[0.000]	[0.004]	[0.000]	[0.484]	[0.000]	

*** (%1), ** (%5), * (%10) symbolize significance at the significance level, [square brackets contain test significance values.]

An examination of the table reveals a high positive correlation between the dependent variables in the different models ($R = 0.756$, $p < 0.01$). A statistically significant and weak positive correlation ($R = 0.203$, $p < 0.01$) was found between the dependent variable ROA and the independent variable RDI at the 1% significance level, while a statistically significant and very weak positive correlation ($R = 0.124$, $p < 0.01$) was found between the dependent variable ROE and the independent variable RDI at the same significance level. In addition, a very weak and positive correlation ($R = 0.149$, $p < 0.01$) was found between the dependent variable ROA and the variable SIZE. By contrast, a moderate negative correlation ($R = -0.508$, $p < 0.01$) was found between the dependent variable ROA and the variable LEV, whereas a moderate positive correlation ($R = 0.449$, $p < 0.01$) was found between the dependent variable ROA and the variable LIQ. Moreover, a weak and positive correlation is observed between the dependent variable ROE and the variable SIZE ($R = 0.275$, $p < 0.01$). Finally, a very weak negative correlation is observed between the dependent variable ROE and the variable LEV ($R = -0.092$, $p < 0.10$), and a very weak positive correlation is observed between the dependent variable ROE and the variable LIQ ($R = 0.113$, $p < 0.01$).

An examination of the correlations between the independent variables reveals correlation coefficients ranging from 0.398 to -0.674. Therefore, a near-perfect multicollinearity problem arising from the correlations between the independent variables is not expected. The statistics calculated for Models 1 and 3 to examine the near-perfect multicollinearity problem are shown in Table 11.

Table 11: Near-Perfect Multicollinearity Statistics for Model 1 and Model 3

Variable	VIF	Tolerance	R^2
RDI	1.230	0.814	0.187
SIZE	1.070	0.938	0.062
LEV	2.000	0.500	0.500
LIQ	2.230	0.449	0.551
Mean VIF	1.630		

An examination of Table 11 reveals the near-perfect multicollinearity statistics calculated for independent and control variables in Models 1 and 3, which are common to both models. An examination of the Variance Inflation Factor (VIF) statistics calculated for the independent and control variables reveals that all are below 5. A VIF value below 5 can be interpreted as indicating that there is no suspicion of near-perfect multicollinearity in the models in question.

The statistics calculated for Models 2 and 4 to examine the near-perfect multicollinearity issue are shown in Table 12.

Table 12: Near-Perfect Multicollinearity Statistics for Model 2 and Model 4

Variable	VIF	Tolerance	R^2
RDI_{t-1}	1.260	0.794	0.206
SIZE	1.070	0.938	0.062
LEV	2.000	0.499	0.501
LIQ	2.270	0.440	0.560
Mean VIF	1.650		

An examination of Table 12 reveals the near-perfect multicollinearity statistics calculated for independent variables in Models 2 and 4, which are common to both models. An examination of the VIF statistics calculated for the independent and control variables reveals that all are below 5. Therefore, it can be said that there is no suspicion of near-perfect multicollinearity for Models 2 and 4.

In this part of the research, the LR test was performed to examine unit and/or time effects for the research models. The Haussman tests were performed to determine between fixed and random effects. In addition, normal distribution tests were conducted for efficient and consistent estimators determined based on the aforementioned specification tests. These tests include cross-sectional dependence. They also include autocorrelation, heteroscedasticity, and error terms. Based on the violations of the

fundamental assumptions made for the estimators determined based on the specification tests, the models were estimated using appropriate robust standard errors and the findings are reported in Table 13.

Table 13: Model Estimation Findings

Variable		Model 1 (ROA)	Model 2 (ROA)	Model 3 (ROE)	Model 4 (ROE)
RDI	β_1	0.4181404**	-	-0.075473	-
	[p]	[0.010]		[0.867]	
RDI_{t-1}	β_1	-	0.2733326**	-	0.2743968
	[p]		[0.014]		[0.469]
SIZE	β_2	0.0073839	0.0058039**	0.0192209	0.0137849
	[p]	[0.403]	[0.043]	[0.465]	[0.614]
LEV	β_3	-0.2654966***	-0.2089476***	-0.467231***	-0.3457026**
	[p]	[0.000]	[0.000]	[0.001]	[0.012]
LIQ	β_4	0 .0088543**	0.005829***	0.0052175	0.0099825
	[p]	[0.010]	[0.004]	[0.528]	[0.181]
Constant	α	-0.0552191	0.0302638	-0.2669967	-0.1969875
	[p]	[0.791]	[0.614]	[0.645]	[0.745]
Diagnostics					
LR Test (Unit and Time)		$\chi^2_{(2)}$=259.36***	$\chi^2_{(2)}$=244.94***	$\chi^2_{(2)}$=172.78***	$\chi^2_{(2)}$=153.40***
		[0.000]	[0.000]	[0.000]	[0.000]
LR Test (Unit)		$\chi^2_{(1)}$=212.93***	$\chi^2_{(1)}$=198.86***	$\chi^2_{(1)}$=153.39***	$\chi^2_{(1)}$=133.95***
		[0.000]	[0.000]	[0.000]	[0.000]
LR Test (Time)		$\chi^2_{(1)}$=56.22***	$\chi^2_{(1)}$=50.63***	$\chi^2_{(1)}$=24.31***	$\chi^2_{(1)}$=20.29***
		[0.000]	[0.000]	[0.000]	[0.000]
Haussman Test		$\chi^2_{(4)}$=13.89***	$\chi^2_{(4)}$=6.11	$\chi^2_{(4)}$=19.8***	$\chi^2_{(4)}$=11.86**
		[0.008]	[0.191]	[0.001]	[0.018]
CD Test		C.D=3.528	C.D=4.562	C.D=12.949	C.D=13.657
		[1.000]	[1.000]	[1.000]	[1.000]
Autocorrelation		M.D.W=1.139	$\chi^2_{(1)}$=28.13***	M.D.W=1.343	M.D.W=1.475
		LBI=1.542	[0.000]	LBI=1.656	LBI=1.785
Heteroskedasticity		$\chi^2_{(66)}$=4974***	F(65, 528)=1.685***	$\chi^2_{(66)}$=9827***	$\chi^2_{(66)}$=15551***
		[0.000]	[0.001]	[0.000]	[0.000]

*** (%1), ** (%5), * (%10) represents significance level, [square brackets contain test significance values.], $\chi^2_{(S.D)}$: Chi-Square test statistic with S.D degrees of freedom, F(S.D.1, S.D.2): Chi-Square test statistic with S.D.1 and S.D.2 degrees of freedom.

- When the findings regarding Model 1 are examined in Table 13, where the dependent variable is ROA, independent variable is RDI and control variables are SIZE, LEV and LIQ, it is documented that there are statistically significant unit and/or time effects in line with the LR Test ($\chi^2_{(2)}$=259.36, p<0.01). While a statistically significant unit effect was observed in line with the LR test conducted to detect the unit effect ($\chi^2_{(1)}$=212.93, p<0.01), a statistically significant time effect was also detected in line with the LR Test conducted to detect the time effect ($\chi^2_{(1)}$=56.22, p<0.01).

For Model 1, the presence of both unit and time effects led to the estimation of the model using two-way estimators that account for individual and time effects. A Hausman test was conducted to choose between fixed effects and random effects estimators within the two-way framework in order to determine the appropriate specification. The test results indicate that the fixed effects estimator is appropriate ($\chi^2_{(4)}$=13.89, p<0.01).

According to the Friedman CD test performed to determine the cross-sectional dependence under the fixed effects estimator for Model 1, it was observed that there was no statistically significant cross-sectional dependence in the model. It was documented that the modified Durbin Watson and Baltagi-Wu LBI statistics performed by Bhargava et al. were significantly smaller than 2. In this case, it can be said that the model has a serious autocorrelation problem. According to the modified Wald test, it was observed that the model had a statistically significant heteroscedasticity problem ($\chi^2_{(66)}$=4974, p<0.01). In order to prevent efficiency losses that may arise from assumption deviations in the model, the model was estimated with Huber, Eicker, and White robust standard errors (Huber, 1967; Eicker, 1967; White, 1980).

When the estimated coefficients in Model 1 are examined; the RDI variable appears to have a statistically significant and positive effect on ROA (β_1=0.4181404, p<0.05). This evidence is also supported in the literature (Karacaer et al., 2009; Artz et al., 2010; Zhu and Huang, 2012; Kalay et al., 2013; Doğan and Yıldız, 2013; Apergis and Sorros, 2014; Ayaydın and Karaaslan, 2014; Doğan and Yıldız, 2016; Freihat and Kanakriyah, 2017; Dağlı and Ergün, 2017; Özer et al., 2019; Sandal and Gacar, 2021; Turhan, 2021; Tung and Binh, 2021; Özkan, 2022; Ergün, 2022; Rahman and Howlader, 2022; Özekenci, 2023; Zengin and Kurt, 2024 and Köksal, 2025). The finding suggests that firms with higher R&D intensity tend to exhibit higher asset profitability, implying that investments in innovative activities contribute positively to firms' operating efficiency and overall financial performance over the period analyzed.

Regarding the control variables, SIZE variable appears to have no statistically significant effect on ROA. On the other hand, LEV variable appears to have a statistically significant and negative effect on ROA (β_3=-0.2654966, p<0.01). This finding is consistent with prior empirical evidence, which suggests that

higher leverage is associated with lower asset profitability (Karjalainen, 2008; Li and Hwang, 2011; Zhu and Huang, 2012; Dağlı and Ergün, 2017; Erdoğan and Yamaltdinova, 2019; Özekenci, 2023). The negative association may reflect the increased financial risk and interest burden arising from higher debt levels, which can constrain firms' operating performance and reduce efficiency in asset utilization. Moreover, excessive reliance on debt may limit financial flexibility and expose firms to solvency pressures, thereby adversely affecting profitability. Overall, the results indicate that leverage plays a critical role in shaping firm performance and should be carefully managed to avoid adverse effects on asset-based returns.

In contrast, LIQ variable appears to have a statistically significant and positive effect on ROA (β_4=0.0088543, $p<0.05$). This evidence is also consistent with the previous empirical evidence (Raheman and Nasr, 2007; Enqvist et al., 2014; Oner, 2016; Nguyen et al., 2024). Adequate liquidity may enable firms to meet their short-term liabilities more efficiently, reduce financial distress costs, and maintain uninterrupted business operations, thereby contributing to higher asset profitability. At the same time, the finding suggests that liquidity management plays a complementary role alongside investment and financing decisions in shaping firm performance. Overall, the results highlight the importance of maintaining sufficient liquidity levels to support ROA.

When the findings regarding Model 2 are examined in Table 13, where the dependent variable is ROA, independent variable is the one-period lagged value of R&D intensity (RDI_{t-1}) and control variables are SIZE, LEV and LIQ, the LR test results reported in Table 13 indicate statistically significant unit and time effects ($\chi^2_{(2)}$=244.94, $p<0.01$). Separate LR tests further show that both the unit effect ($\chi^2_{(1)}$=198.86, $p<0.01$), and the time effect ($\chi^2_{(1)}$=50.63, $p<0.01$) are statistically significant.

Given the presence of unit and time effects for Model 2, a Hausman test was conducted to select between fixed effects and random effects estimators. The results indicate that the random effects estimator is appropriate ($\chi^2_{(4)}$=6.11, $p>0.10$).

The Friedman CD test, performed to determine cross-sectional dependence under the random effects estimator for Model 2, shows that there is no statistically significant cross-sectional dependence. The LM Lagrange multiplier shows that there is a significant autocorrelation problem in the model 2 ($\chi^2_{(1)}$=28.13, $p<0.01$). The Levene Brown and Forsythe tests show that the model has a statistically significant heteroscedasticity problem ($F(65, 528)=1.685$, $p<0.01$). In order to prevent efficiency losses that may arise from assumption deviations in the model, the model was estimated with Huber, Eicker, White robust standard errors (Huber, 1967; Eicker, 1967; White, 1980).

When the estimated coefficients in Model 2 are examined, it is observed that the lagged value of the RDI variable has a statistically significant and positive effect on ROA (β_1=0.2733326, $p<0.05$). This evidence is also supported in the literature (House et al, 1994; Artz et al, 2010; Zhu and Huang, 2012; Zhu & Huang, 2012; Ayaydın and Karaaslan, 2014; Usman et al., 2017; Dağlı and Ergün, 2017; Özkan, 2022). The finding suggests that the benefits of R&D activities are not fully realized contemporaneously but tend to materialize with a time lag, reflecting the delayed nature of innovation-related investments. Firms that increased their R&D intensity in the previous period appear to achieve higher asset profitability in subsequent periods, which may be attributed to improvements in operational efficiency, product development, or process innovation. Overall, the results emphasize the importance of considering lagged R&D effects when evaluating the relationship between innovative activities and firm performance.

With respect to control variables, it is found that SIZE variable has a statistically significant and positive effect on ROA (β_2=0.0058039, $p<0.05$). This evidence is also supported in the literature Karacaer et al. (2009), Zhu and Huang (2012), Ayaydın and Karaaslan (2014), Restuti et al. (2018), Tran and Vo (2018), Erdoğan & Yamaltdinova (2019) and Soetanto and Liem (2019). The finding suggests that larger firms tend to achieve higher asset profitability, potentially due to advantages such as economies of scale, stronger market positions, and more efficient utilization of resources.

In contrast, statistically significant and negative relationship has been detected for the link between LEV variable and ROA (β_3=-0.2089476, $p<0.01$).

Similar to the SIZE variable, the effect of LIQ variable on ROA is also statistically significant and positive (β_4=0.005829, $p<0.01$). This evidence is also supported in the literature (Raheman and Nasr, 2007; Enqvist et al., 2014; Oner, 2016; Nguyen et al., 2024). The finding suggests that firms with stronger liquidity positions tend to utilize their assets more efficiently, thereby achieving higher profitability. Adequate liquidity may support smoother business operations and reduce short-term financial constraints, which can contribute positively to asset-based returns.

When the findings for Model 3 are examined in Table 13, where the dependent variable is ROE, the independent variable is RDI and control variables are SIZE, LEV and LIQ, the LR test reveals that there are statistically significant unit and/or time effects ($\chi^2_{(2)}$=172.78, p<0.01). Furthermore, the LR test performed to detect the unit effect revealed a statistically significant unit effect ($\chi^2_{(1)}$=153.39, p<0.01). Similarly, the LR test performed to detect the time effect also revealed a statistically significant time effect ($\chi^2_{(1)}$=24.31, p<0.01). Accordingly, the Hausman test applied to select between fixed and random effects estimators shows that the fixed effects estimator is appropriate ($\chi^2_{(4)}$=19.8, p<0.01).

According to the Friedman CD test performed to determine the cross-sectional dependence under the fixed effects estimator for Model 3, the results indicate that there is no statistically significant cross-sectional dependence in the model. It was observed that the modified Durbin Watson and Baltagi-Wu LBI statistics by Bhargava et al. were significantly smaller than 2. In this case, it can be said that the model has a serious autocorrelation problem. According to the modified Wald test, the results show that the model has a statistically significant heteroscedasticity problem ($\chi^2_{(66)}$=9827, p<0.01). In order to prevent efficiency losses that may arise from assumption deviations in the model, the model was estimated with Huber, Eicker, White robust standard errors (Huber, 1967; Eicker, 1967; White, 1980).

When the estimated coefficients in Model 3 are examined, the RDI variable has no statistically significant effect on ROE. This finding is consistent with the results of the study by Bouaziz (2016), Korkmaz (2019) and Geçici et al. (2025). Similarly, SIZE variable and LIQ variable are also not found to have a statistically significant effect on ROE.

On the other hand, the LEV variable has a statistically significant and negative effect on ROE (β_3=-0.467231, p<0.01). This finding is also consistent with the prior empirical evidence (Erdoğan and Yamaltdinova, 2019; Sandal and Gacar, 2021). The negative and statistically significant relationship between leverage and ROE suggests that higher debt levels may place pressure on shareholder returns. Increased leverage can raise interest obligations and financial risk, which may limit the firm's ability to generate returns for equity holders. This result indicates that leverage plays an important role in shaping equity-based performance

When examining the findings for Model 4 in Table 13, where the dependent variable is ROE, the independent variable is one-period lagged value of the RDI variable (RDIt-1) and the control variables are control variables are SIZE, LEV and LIQ, the LR test reveals statistically significant unit and/or time effects ($\chi^2_{(2)}$=153.40, p<0.01). The LR test performed to detect the unit effect revealed a statistically significant unit effect ($\chi^2_{(1)}$=133.95, p<0.01), and the LR test performed to detect the time effect revealed a statistically significant time effect ($\chi^2_{(1)}$=20.29, p<0.01). Accordingly, the Hausman test applied to select between fixed and random effects estimators shows that the fixed effects estimator is appropriate ($\chi^2_{(4)}$=11.86, p<0.05).

Friedman CD test, performed to determine cross-sectional dependence under the fixed effects estimator for Model 4, revealed that there was no statistically significant cross-sectional dependence. The modified Durbin Watson and Baltagi-Wu LBI statistics by Bhargava et al. are significantly less than 2. This suggests a serious autocorrelation problem in the model. According to the modified Wald test, the model exhibits a statistically significant heteroscedasticity problem ($\chi^2_{(66)}$=15551, p<0.01). To prevent efficiency losses that may arise from model assumption deviations, the model was estimated with Huber, Eicker, and White robust standard errors (Huber, 1967; Eicker, 1967; White, 1980).

The results for Model 4 show that the one-period lagged R&D variable, SIZE variable and LIQ variable does not have a statistically significant effect on ROE while The LEV variable's effect on ROE is statistically significant and negative (β_3=-0.3457026, p<0.05). As it stated in model 3, this finding is also consistent with the prior empirical evidence (Erdoğan and Yamaltdinova, 2019; Sandal and Gacar, 2021). The negative and statistically significant relationship between leverage and ROE suggests that higher debt levels may place pressure on shareholder returns. Increased leverage can raise interest obligations and financial risk, which may limit the firm’s ability to generate returns for equity holders. This result indicates that leverage plays an important role in shaping equity-based performance.

6.CONCLUSION

This thesis examines the effects of R&D investments on financial performance and highlights the importance of these activities in enhancing financial outcomes and competitive advantage. The empirical results show that both current and one-period lagged R&D investments have a positive effect on return on assets (ROA). These results indicate that R&D investments improve firms' profitability not only in the year they are incurred, but also through lasting effects in subsequent periods. This persistence suggests that firms benefit from R&D as a strategic investment rather than a short-term expense, while investors may interpret R&D engagement as an indicator of sustainable performance. Accordingly, the findings provide empirical support for government policies designed to encourage long-term R&D activities.

In contrast, no statistically significant relationship is found between R&D investments and return on equity (ROE). The absence of a statistically significant effect of R&D intensity on ROE suggests that the impact of R&D activities may not be immediately reflected in shareholder returns within the period analyzed. This finding may indicate that the financial benefits of R&D investments materialize over a longer horizon than captured by short-term equity-based performance measures. Another reason why R&D has not had an impact on ROE could be due to the inadequacy of R&D spending in Türkiye. Despite increased incentives for the R&D activities in Türkiye, amount of investment remains low compared to average of OECD countries. Total R&D expenditures by financial and non-financial companies in Türkiye in 2024 were approximately 422.3 billion TL, of which 25.1%, or 106 billion TL, was supported by incentives. While the ratio of R&D expenditures to GDP in OECD countries was 2.7 in 2023, it was 1.39 in Türkiye. One another reason why R&D expenditures were not found to have an impact on ROE could be that these expenditures do not immediately manifest their impact. Polat (2011) stated in his study that R&D begins to positively affect business performance after a certain period of time, as a result of the technology and innovation acquired; and that it is not possible to see the positive impact of R&D expenditures unless technology and innovation are acquired.

Top management aims to create long-term value for shareholders and increase their future returns. To gain a competitive advantage, companies not only invest in fixed assets but also see research and development as a necessity. R&D means making innovations, developing new products, and improving processes to follow a different strategy from competitors. When the link between innovation and profitability is examined, it is seen that at the company level, R&D helps firms gain competitive advantage, use their production systems more efficiently, and increase market share. At the national level, it supports social welfare by ensuring the effective use of resources, promoting sustainable economic growth, and improving the overall knowledge base.

Firms can improve operating profitability and efficiency by aligning their R&D investments with available resources and clearly defined strategic priorities. This process may be supported by public policies through financial incentives and tax advantages that promote R&D activities, while cooperation between public and private actors can further enhance the effectiveness of such investments at both sectoral and national levels. Firms are also expected to continuously improve their innovation processes and to cultivate an organizational environment that encourages innovative behavior in order to increase the returns obtained from R&D. Taken together, these considerations suggest a structured approach to managing R&D investments that may contribute to stronger financial performance over time. Moreover, the findings of this study provide a useful starting point for future empirical research seeking to explore the impact of R&D investments on firm performance across different economic conditions and sectoral settings.

Despite its contributions, the study is subject to certain limitations. First, the empirical analysis is confined to non-financial manufacturing firms listed on Borsa İstanbul and covers the period from 2013 to 2022, including only firms with continuous and complete data. In addition, observations for 2023 and 2024 are excluded in order to avoid potential distortions related to inflation accounting practices, which represent a further limitation of the analysis. Future research may extend the scope of the current study by examining the effects of R&D investments on firm performance across different sectors or subsectors within manufacturing. Further contributions may also be achieved by considering both capitalized and expensed R&D, excluding depreciation and amortization effects, over longer and alternative time horizons.

In conclusion, this thesis highlights the important role of R&D investments in shaping firms' financial performance. Beyond their direct impact on profitability, R&D activities strengthen firms' competitive positions, enhance innovation capabilities, and contribute to sustainable long-term growth. From this perspective, the adoption of strategic approaches that encourage innovation and technological advancement by both firms and policymakers appears to be a key element in achieving long-term economic objectives. Moreover, the wider implications of R&D activities for social welfare and economic stability underline the importance of continuing to evaluate these investments within a comprehensive and long-term analytical framework.

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