JELS Journal of Economics, Law & Society

ESREIN Economic and Social Research Institute

The Lagged Financial Effects of R&D Investments on IT Company Performance in Bosnia and Herzegovina

Jasmina Džafić,[1*] Šeherzada Šakić,[1] Aida Zahirovic Hadžić[2]

[1] *Faculty of Economics, University of Zenica, Zenica, Bosnia and Herzegovina*

[2] *ASA Banka d.d. Sarajevo, Sarajevo, Bosnia and Herzegovina*

**Email: jasmina.dzafic@unze.ba*

Abstract

Investments and allocations in research and development (R&D) represent a main driver of competitive advantage, innovation, and sustainable growth for the most reputable IT companies in Bosnia and Herzegovina. This study empirically examines the impact of R&D expenditures on corporate performance and market value over the period 2022–2024, using comprehensive and balanced data that ensures high analytical precision. Descriptive statistics indicate significant variability in the expected growth rate measured by the DCF method, while correlation analysis confirms positive and statistically significant relationships between R&D expenditures and key performance indicators (ROA, ROE, DCF), with stronger links observed in 2023 and 2024. Regression analyses, demonstrate that increased R&D allocations significantly enhance current and future profitability, market value growth, and competitive positioning, with variations depending on year and indicator. The results underscore the strategic importance of continuous and well-planned R&D investments for achieving sustainable growth, creating comparative advantages, and maximizing corporate value, providing empirical evidence and practical implications for managers and investors in the IT sector in Bosnia and Herzegovina.

Article History

Received: November 24, 2025
Accepted: December 25, 2025
Published: December 30, 2025

Keywords

R&D; DCF method; ROA; ROE; regression analysis; correlation analysis; lagged effects; IT sector of Bosnia and Herzegovina

JEL Codes

G31; G32; C10; C50; O30;

How to Cite

Džafić, J., Šakić, Š, & Zahirovic Hadžić, A. (2025). The Lagged Financial Effects of R&D Investments on IT Company Performance in Bosnia and Herzegovina. *Journal of Economics, Law and Society, 2(2)*, 59-72. https://doi.org/10.70009/jels.2025.2.2.4

1. Introduction

Investments in knowledge and innovation, i.e., research and development, play a significant role in the company's efforts to achieve the desired profit and realize long-term sustainable growth. In today's world, when companies are surrounded by strong competition and challenging market conditions, through the ability to innovate, create and produce new products, develop new production processes and technologies, and respond to the challenging and changing demands of customers, they can create and preserve a competitive advantage.

The importance of R&D has been widely documented in economic history, particularly in analyses of technological revolutions and long-term productivity growth (Solow, 1956, 1957; OECD, 2015). Neoclassical economic thought, based on Robert Solow's model from the 1950s, emphasizes the complex of technological changes as a key factor in economic growth. Solow's analysis showed that approximately 50% of historical growth in industrialized countries cannot be attributed solely to physical capital and labor, but to a third factor, namely, residual. This residual includes intangible factors such as the development of means of production, changes in education, research and

development, and organizational and production methods. Despite adopting the complexity of technological changes as a key driver of economic dynamics, neoclassical theory ignored the question of the source of these changes, presenting it as a key flaw. Also, neoclassical economists were not able to explain the variation of residuals

However, neoclassical considerations have nevertheless placed research and development activities as important drivers of economic growth. Most countries invest significant funds in research and development, recognizing it as a key factor for achieving progress in the technological sector and long-term economic profits (Sokolov-Mladenović et al., 2016).

Nowadays, research and development expenditures are very noticeable in fast-growing sectors of the economy, such as the technology sector. Development occurs through the digital revolution, also known as the third industrial revolution, when companies in the technological sector gradually take a leading position in modern economies. In an effort to maintain and improve this position, they resort to investments specifically related to research and development. Global companies spend billions of dollars annually to produce the latest and most sought-after products.

The growing importance of ITC systems over time requires long-term planning and implementation. The process of developing and implementing a new management system involves steps such as harmonizing the corporate strategy, defining the value creation system, establishing the control system, implementing continuous management processes, and enhancing external communication (Daum, 2003). R&D in these processes is of great importance, considering that the allocation in this domain is crucial for the creation of new systems.

Research focused on the impact of research and development expenditures on the performance and value of companies in the technology sector is very current and significant. A large number of international studies have been conducted to examine the impact of investment in research and development on company performance. However, domestic authors study these concepts very little or from a limited number of aspects. Most studies indicate a positive effect of research and development on a company's performance and value, but some results suggest a negative impact of these activities. The data obtained through these studies are important for understanding the position of BiH IT companies in comparison with global competitors.

At the national level, digital transformation is often associated with long-term economic modernization. However, the present study focuses on firm-level financial outcomes; therefore, macroeconomic aspects are referenced only to contextualize the growing relevance of the IT sector. The development of digital technologies should enable important structural changes in the economy of Bosnia and Herzegovina, strengthening the position of the IT industry as a leading source of growth and employment. In order to reach an adequate level of development, close to the most developed countries in Europe, according to projections, Bosnia and Herzegovina needs several decades, and if the growth strategy is based on innovations, the knowledge society and the IT sector, that period can be significantly shortened (Arnaut & Jerković, 2017).

Research and development activities represent an emerging concept that is essential for every company to succeed in a competitive and challenging environment. These activities greatly affect the company's performance and represent a means of improving it. Consequently, companies that invest more in research and development are expected to earn more than those that do not. The company's performance will exceed the costs of research and development, and after reaching equilibrium, they will be compensated by the benefits obtained.

Company performance is influenced by three key variables. First, the added value is influenced by the company's growth, specifically through its annual growth in total assets. Second, economic

value is expressed through profitability (the ratio of earnings before interest and taxes to total assets). Third, accounting-based earnings are expressed as return on assets (ROA), return on equity (ROE), and return on sales (ROS). In this paper, the focus will be on ROA and ROE as key indicators.

Based on these considerations, it is clear that research on the relationship between research and development activities and company performance remains an open question that requires additional theoretical and empirical clarifications. Various findings in the literature suggest that the nature of this relationship can be complex, influenced by both the company's internal characteristics and external market factors. Therefore, it is necessary to examine existing research to identify key patterns, as well as gaps that open up space for further analysis. In the next section, a review of the relevant literature will be presented, serving as a basis for developing research hypotheses.

2. LITERATURE REVIEW

Through their studies, numerous authors connect research and development (R&D) with the success of companies. Chao-Hung Wang (2011) emphasizes that organizations must manage their resources wisely in order to survive in the competitive market. He claims that companies with unique, non-imitable resources have an advantage in increasing performance. Investing in valuable resources, such as R&D, is crucial, despite the high costs. Although companies invest millions in research and development, the costs are justified by the internal ability to innovate and improve performance. Company performance depends on R&D resources, which become a key means of improvement in the age of technology. It is expected that companies with higher investments in research and development will generate higher revenues than those that do not (Wang, 2011; Cohen & Levinthal, 1990).

Sokolov Mladenović et al. (2016) statistically analyze the impact of investment in research and development on economic growth in the European Union, for the period 2002 to 2012. For the same purpose, a multiple regression model was constructed, in which the dependent variable was the real rate of economic growth, and the independent variable was the value issued for research and development as a percentage of GDP. In addition to the independent variable, a control variable was also introduced, which has a significant impact on the rate of real economic growth. Gross investments in fixed capital as a percentage of GDP, general government final consumption expenditures as a percentage of GDP, birth rate and financial crisis were used as control variables. Based on the obtained results, the authors conclude that investment in research and development has a positive impact on economic growth in the European Union. Similar results were presented in the research of Griliches (1979), who showed long-term positive effects of R&D investments on productivity and economic growth.

Ghaffar and Khan (2014) analyzed the impact of budget allocations for research and development on the performance of companies in the pharmaceutical industry. The performance of companies was measured through the ratios of return on assets, return on capital, and earnings per share. The results confirmed a positive correlation between dependent and independent variables. Thus, the research reveals that the performance of the company will increase if the research and development budget is increased (Ghaffar & Khan, 2014).

Park et al. (2019) focused their research on examining the impact of technology and market dynamics on the business performance of support services for small and medium-sized enterprises. Technology and market dynamics are introduced as moderating variables, while the degree of utilization that provides support to small and medium enterprises is presented as an independent variable. The degree of contribution to business performance, such as income, exports, and employment, is presented as a dependent variable. Upon completing the research, it is concluded that the support

services of small and medium-sized enterprises have a direct impact on business performance, and they also have an indirect impact on the business performance of SMEs through their degree of contribution to SME managers' decision-making. According to the above, technology and market dynamics have a mediating and moderating effect on the business performance of SMEs. A similar conclusion is drawn from the research of Deeds, DeCarolis & Coombs (2000), which highlights the importance of technological competence and knowledge management for the performance of small and medium-sized enterprises.

Abdel Razaq et al. (2017) conducted research on the impact of R&D expenditures on company performance. The purpose of this study is to investigate whether research and development (R&D) expenditures have an impact on the performance of Jordanian pharmaceutical companies listed on the Amman Stock Exchange in Jordan. During the research, a quantitative approach was employed to analyze data from a sample of six companies, spanning the period from 2006 to 2015. Empirical research was conducted using simple linear regression analysis to reveal the impact of research and development on company performance. Company performance was measured by return on assets (ROA), return on equity (ROE) and earnings per share (EPS) as proxies for measuring company performance, and for measuring R&D expenditure included the following items: research, experiments, studies and courses. This research showed that there is a significant impact of research and development expenditures on company performance (ROA, ROE and EPS), which is in line with the results for developed countries. Additionally, R&D expenditures in the current year yield future benefits, including a greater market share, a higher stock price, and a better reputation (Abdel Razaq et al., 2017).

Research by Chan, Lakonishok, & Sougiannis (2001) examines whether stock prices fully reflect the value of a firm's intangible assets, with a focus on research and development activities. For R&D companies, high R&D intensity has a characteristic effect on returns for two groups of stocks. Within a set of growth stocks, R&D-intensive stocks tend to outperform stocks with little or no R&D investment. Companies with high R&D expenditures relative to their market capitalization show strong signs of mispricing. Additionally, the intensity of research and development is positively correlated with the volatility of returns. Although most studies confirm the positive impact of R&D on performance, some studies indicate risks, such as increased variability of returns and misvaluation of capital. These contradictions justify conducting additional empirical analysis in the local context (Chan et al., 2001; Lev, 2001).

In their work, He and Estebanez (2023) examined the relationship between a company's investment in research and development and its operational performance. They collected data from 1,262 SMEs in the ICT service sector in China between 2011 and 2020. Research and development investment was selected as the independent variable, while financial performance (ROA, ROE, liquidity ratio, debt asset ratio, and interest coverage ratio) and market value (Tobin's Q) were selected as dependent variables. Multiple linear regressions were used to determine if there was a correlation between these variables. Primarily, R&D investment enhances current profitability and there is a one-period lag in these relationships. Second, R&D has a negative correlation with the short-term ability to pay debt, but is positively correlated with the long-term ability, and these effects persist for a certain period. Finally, R&D investment has a negative impact on the current state of market value, but R&D investment within two lagged periods still has a positive impact (He & Estébanez, 2023).

Also, the impact of R&D expenditures and advertising on creating comparative advantage and achieving profit in business was analyzed. By controlling for firm-specific unobserved factors and analyzing the feedback between discretionary spending and profitability, this study finds lower accounting and stock returns on R&D and advertising expenditures compared to earlier research. The results suggest that isolation mechanisms, which typically serve as a barrier to imitation, are insufficient for the aforementioned expenditures, as well as for advertising, to create a long-term

comparative advantage on average. These findings point to challenges in achieving profit through these key business aspects and encourage further research to better understand the dynamics between costs, profits and long-term competitive advantages (Erickson & Jacobson, 1992; Hall, 1993).

Based on previously analyzed theoretical and empirical research, it is clear that investments in research and development can significantly impact a company's performance, although the results are not always unambiguous. While most studies confirm the positive impact of R&D on the value and profitability of companies, some works suggest possible negative or contradictory effects, particularly in high-risk conditions or specific market circumstances. These variations in findings underscore the need for further empirical research in the technology sector of Bosnia and Herzegovina. Therefore, in the next chapter, the research hypotheses derived from the literature review will be defined and tested through the empirical analysis of the company's financial indicators.

Although previous studies consistently examine the effects of R&D on firm value and performance, the operationalization of these outcomes varies. In this study, firm value is measured through the expected growth rate obtained from a DCF-based estimate, while performance is assessed through ROA and ROE, following the approaches used by Freihat and Kanakriyah (2017), He and Estébanez (2023), and Razaq et al. (2017). These indicators align with the literature that treats profitability and market valuation as the primary channels through which R&D generates financial returns.

3. Methodology

The primary research goal of the work is to analyze, based on theoretical and empirical findings, whether there is an impact of investment in research and development on the value of companies in the technology sector, which operate in the territory of Bosnia and Herzegovina, to what extent the impact is present and what it is like. In addition to the primary goal, another objective is to assess the impact of these investments on the performance of companies in the IT sector in Bosnia and Herzegovina.

3.1. Sample data and variables

Due to the specific treatment of the term IT company and the complexity of the activity itself, for the purpose of conducting the analysis and construction of econometric models, the most significant companies that invest in research and development in Bosnia and Herzegovina were selected, which are members of the Bit Alliance association, whose activity code is 62.01 - computer programming, consulting and related activities. There is a total of 20 companies, members of the Bit Alliance association, registered under this activity code. Bit Alliance member firms represent the most R&D-active segment of the BiH IT industry, making the sample appropriate for examining firms where R&D intensity is economically meaningful. When collecting data, balance sheets for 14 companies, covering the period from 2022 to 2024 and available on the LRC database, were included in the sample.

According to Palepu, Healy, & Peek (1996), the most widely used method for valuing intangible assets, especially technological intangible assets, is DCF, and its essence is the discounting of predicted total cash flows. This approach involves making detailed, multi-year cash flow forecasts. For this reason, the value of the companies in the sample was measured using the DCF method.

To estimate firm value and derive the expected five-year growth rate (DCF%), a simplified discounted cash flow (DCF) approach was applied. The analysis was conducted for 14 IT companies that are members of the Bit Alliance, using financial statements from the LRC database for the period 2022–2024.

Future cash flows were projected by extrapolating revenues, operating costs, EBIT, depreciation, capital expenditures, and changes in working capital based on historical trends observed in the 2022–2024 financial statements. Free cash flow to the firm (FCFF) was calculated as:

$$FCFF = EBIT(1-t) + Depreciation - CAPEX - \Delta WC$$

The weighted averagecost of capital (WACC) was used as the discount rate. The cost of equity was estimated using the CAPM model with a risk-free rate from the Banking Agency of BiH, an equity risk premium for Bosnia and Herzegovina, and an industry beta obtained from Damodaran's database. The cost of debt was derived from average long-term interest rates published by the Central Bank of BiH.

Projected FCFFs for a five-year forward period were discounted to present value, and a terminal value was calculated using the perpetual growth formula:

$$TV = FCF_n (1+g) / (WACC - g)$$

The present value of projected cash flows and the terminal value were summed to obtain firm value. The expected growth rate (DCF%) used in this study represents the average annual growth implied by the DCF-based projections of net income and equity over the five-year forecast horizon. The measure should be interpreted cautiously due to simplified forecasting assumptions.

In addition to the above, the company's performance will also be used as a dependent variable. Looking back at previous research (Freihat and Kanakriyah, 2017; He and Estébanez, 2023) within the mentioned subject, it is evident that the authors measured company performance to the greatest extent by return on assets (ROA) and return on capital (ROE), which will be the case in this paper as well. The return on assets and return on capital from 2024 will be used as dependent variables, representing the performance of the companies in the sample.

R&D intensity was defined as the ratio of total annual R&D expenditures to total revenues. This measure is consistent with prior literature and captures the extent to which a firm allocates its resources to innovation-related activities. R&D expenditures were taken from the financial statement notes under the category 'intangible asset development costs' and, where not separately disclosed, from the item 'research and development expenses' reported in operating expenses. Only firms with explicitly reported R&D figures were included in the sample. Although three years of historical data were used to construct lagged R&D intensity variables, the regression analysis itself is cross-sectional, with N = 14 observations.

The ***Table 1*** presents a summary of the variables that will be used to model the research relationships.

Table 1: Model variables

Variable	*Name*	*Code*	*Calculation*
Dependent	Expected company growth rate measured by the DCF method for a five-year period	$DCF_{\%}$	DCF method
	Return on asset 2024	ROA_t	net profit/assets
	Return on capital 2024	ROE_t	net profit/capital
Independent	% expenditures on R&D in 2024	$expendituresR\&D_t$	$expendituresR\&D_t$/ $asset_t$
	% expenditures on R&D in 2023	$expendituresR\&D_{t-1}$	$expendituresR\&D_{t-1}$/ $asset_{t-1}$
	% expenditures on R&D in 2022	$expendituresR\&D_{t-2}$	$expendituresR\&D_{t-2}$/ $asset_{t-2}$

Source: Authors' own.

3.2. Hypotheses and research models

The central hypothesis is:

H1. There is a statistically significant positive relationship between investment in research and development and the value of enterprises in the technology sector.

Additional hypothesis:

H2. Higher investments in research and development are positively related to the return on assets of companies in the technology sector.

H3. Higher investments in research and development are positively related to the return on capital of companies in the technology sector

To verify and test the defined hypotheses, regression-correlation analysis will be employed, preceded by the calculation of descriptive statistics measures and testing the assumption of normality, a prerequisite for using regression analysis.

3.2.1. Main regression model

After the dependent and independent variables have been defined, and considering previous similar research and the specific characteristics and goals of this work, the basic regression model can be formulated.

$$DCF_{\%} = \beta_0 + \beta_1 expendituresR\&D_{t-m} + \varepsilon_t$$

Where are:

$DCF_{\%}$ – Expected company growth rate for a five-year period calculated using the DCF method

β_0 – model constant,

β – estimated regression parameter,

$expendituresR\&D_{t-m}$ – Share of research and development expenditures in assets for period *t* (t = 2024) minus *m* years $m \in (0,2)$.

For the purposes of testing auxiliary hypotheses, two more models were set up, due to the greater precision of the results themselves. The first auxiliary model is used to test the first auxiliary hypothesis, during which it will be clear whether research and development expenditures have a significant impact on the return on assets of IT companies in Bosnia and Herzegovina.

First additional outcome model

$$ROA_t = \beta_0 + \beta_1 expendituresR\&D_{t-m} + \varepsilon_t$$

ROA_t – returns on asset at time *t* (t = 2024), and the rest is as defined earlier.

For the purpose of testing the second auxiliary hypothesis, another model was established to determine the impact of research and development expenditures on return on capital in IT companies.

Second additional outcome model

$$ROE_t = \beta_0 + \beta_1 expendituresR\&D_{t-m} + \varepsilon_t$$

ROE_t – Rate of return on capital at year *t* (t = 2024), and the rest is as defined earlier.

3.3. Empirical research results

The first step before conducting regression analysis is to present the results of descriptive statistics for the dependent and independent variables of the model, as well as normality tests for the same variables.

Table 2: Results of descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
expendituresR&D 2022	14	0.2568	0.1990	0.0033	0.7111
expendituresR&D 2023	14	0.2386	0.1648	0.0036	0.5717
expendituresR&D 2024	14	0.2253	0.1557	0.0071	0.5707
$DCF_{\%}$	14	7.9850	17.5772	0.0001	50.4857
ROA 2024	14	0.3109	0.3164	0.0017	0.8383
ROE 2024	14	0.4820	0.4624	0.0017	1.5420

Source: Authors' calculation.

Based on ***Table 2***, data for both dependent and independent variables from all 14 technology companies in the sample were included, ensuring higher accuracy due to balanced data. Mean, standard deviation, minimum, and maximum values were calculated for each variable. The highest variability is observed in the expected growth rate, as measured by the DCF method, due to large differences between the highest and lowest projected growth rates. In contrast, other variables exhibit relatively low standard deviations. The relatively low variance in R&D intensity across firms indicates that differences in outcomes are not driven by extreme outliers, which increases the interpretability of regression coefficients. A normality check of the data distribution was also conducted.

To assess the distribution of the data, the Shapiro-Wilk test was employed, which is recommended for use with samples of 30 units or fewer (***Table 3***). After checking, it was determined that the dependent variable, the expected growth rate measured by the DCF method, does not meet the assumption of normality, and its transformation into a logarithmic value of the same variable was performed, which, according to the test results, meets this assumption.

Table 3: Results of the Shapiro-Wilk test for checking the data distribution

Variable	Obs	Prob>z	Assumption of normality
expendituresR&D 2022	14	0.19397	fulfilled
expendituresR&D 2023	14	0.33229	fulfilled
expendituresR&D 2024	14	0.37098	fulfilled
$lnDCF_{\%}$	14	0.17255	fulfilled after transformation to log
ROA 2024	14	0.05362	fulfilled
ROE 2024	14	0.09250	fulfilled

Source: Authors' calculation.

After the assumption of normality was satisfied for the selected variables of the model, a correlation analysis was performed, the results of which are presented below.

The correlation analysis in ***Table 4*** reveals that the dependent variable, the expected growth rate (logarithmic value, DCF method, 5-year period), exhibits a positive correlation with the independent variables, specifically the share of R&D expenditures in total assets for 2022, 2023, and 2024. The relationship is moderately strong for 2022 and 2023 (correlation coefficient 0.4–0.6) and strong for 2024 (0.6–0.8).

The dependent variable of the first auxiliary model (*Table 5*), ROA2024, has a positive and moderately strong relationship with the independent variables, with the highest impact on R&D expenditures in 2023.

Table 4: Results of correlation analysis of the variables of the main regression model

	lndcf	expendituresR&D 2022	expendituresR&D 2023	expendituresR&D 2024
$lnDCF_{\%}$	1.0000			
expendituresR&D 2022	0.5155***	1.0000		
expendituresR&D 2023	0.5737***	0.9864***	1.0000	
expendituresR&D 2024	0.6079***	0.8137***	0.9214***	1.000

Source: Authors' calculation. (*** p < 0,05)

The third correlation analysis conducted examines the relationship between the dependent variable of the second auxiliary model and the dependent variables. As in the previous case, the strongest connection is present with expenditures from 2023. The dependent variable of the second auxiliary model, ROE2024, has a positive but weak relationship with the independent variables (see *Table 6*).

Table 5: Results of correlation analysis of the variables of the first additional outcome model

	roa2024	expendituresR&D 2022	expendituresR&D 2023	expendituresR&D 2024
ROA2024	1.0000			
expendituresR&D 2022	0.5058***	1.0000		
expendituresR&D 2023	0.5582***	0.9864***	1.0000	
expendituresR&D 2024	0.4503***	0.8137***	0.9214***	1.000

Source: Authors' calculation. (*** p < 0,05)

Table 6: Results of correlation analysis of variables of the second additional outcome model

	roe2024	expendituresR&D 2022	expendituresR&D 2023	expendituresR&D 2024
ROE2024	1.0000			
expendituresR&D 2022	0.4417***	1.0000		
expendituresR&D 2023	0.4655***	0.9864***	1.0000	
expendituresR&D 2024	0.3047***	0.8137***	0.9214***	1.000

Source: Authors' calculation. (*** p < 0,05)

Table 7: Main regression model

Independent variable	Dependent variable – $lnDCF_{\%}$		
$\beta_1 expendituresR\&D_{2022}$	8.29399		
$\beta_1 expendituresR\&D_{2023}$		11.00095	
$\beta_1 expendituresR\&D_{2024}$			12.80082
P value (P > z)	0.0590	0.0320	0.0210
Const	-2.7809	-3.2599	-3.5189
R^2	0.2658	0.2733	0.3696
Prob > F	0.0592	0.0319	0.0211

Source: Authors' calculation.

The results of the basic model (*Table 7*) indicate that research and development (R&D) expenditures

have a positive impact on the company's expected growth, as measured by the DCF method, for the period 2022–2024. The strongest relationship is observed for R&D expenditures from 2024, while the weakest is for 2022. The statistical significance ranges from 0.05 to 0.10, and the coefficient of determination (R^2) for 2024 is 0.3696, indicating satisfactory explanatory power of the model.

Table 8: First additional outcome model

Independent variable	*Dependent variable – ROA* $_{2024}$		
$\beta_1$expendituresR&D $_{2022}$	0.7850		
$\beta_1$expendituresR&D $_{2023}$		1.0325	
$\beta_1$expendituresR&D $_{2024}$			0.9146
P value (P > z)	0.0650	0.0380	0.1060
Const	0.1078	0.0645	0.1049
R^2	0.2558	0.3116	0.2027
Prob > F	0.0592	0.0380	0.1062

Source: Authors' calculation.

In the first auxiliary model (***Table 8***), which examines the impact of R&D expenditures on return on assets (ROA), all independent variables show a positive correlation with the dependent variable. The strongest effect is recorded for R&D from 2023, while the 2022 expenditures are not statistically significant. The R^2 for 2023 is 31.16%, and in other periods it exceeds 0.2, indicating a moderate explanatory power of the model.

Table 9: Second additional outcome model

Independent variable	Dependent variable – ROE$_{2024}$		
$\beta_1$expendituresR&D $_{2022}$	1.0395		
$\beta_1$expendituresR&D $_{2023}$		1.3058	
$\beta_1$expendituresR&D $_{2024}$			0.9387
P value (P > z)	0.1140	0.0930	0.2890
Const	0.2130	0.1704	0.2705
R^2	0.1951	0.2167	0.0929
Prob > F	0.1139	0.0935	0.2894

Source: Authors' calculation.

The third model presented in ***Table 9***, analyzing return on equity (ROE), shows that R&D expenditures from 2023 have the strongest positive impact, while results for 2022 and 2024 are not statistically significant. The R^2 for 2023 is 21.67%, whereas in other years the explanatory power of the model is unsatisfactory. These results suggest a correlation between earlier R&D expenditures and 2024 outcomes.

3.4. Interpretation and discussion of results

The empirical analysis was conducted on a sample of 14 companies from the IT sector in Bosnia and Herzegovina, all registered under the same activity code. These companies were selected to include those with the most significant expenditures on research and development in the sector. Dependent and independent variables were defined in accordance with the main and additional research hypotheses, as well as the results of previous research in the relevant area, considering the specific characteristics of the observed sample. The first step of the analysis involved presenting the results of descriptive statistics, which were used to describe the data from the sample. Following this, data distribution testing and normality checks were conducted. The initial results indicated

that all independent variables, as well as dependent variables of the first and second additional outcome models, meet the assumption of normality, based on the Shapiro Wilk test, except for the dependent variable of the basic regression model of the expected growth rate of the company, measured by the DCF method, for which it was necessary to transform it into its logarithmic value. After that, all variables satisfied the assumption of normality, which is the basic assumption of regression analysis. Before conducting the regression analysis, a correlation analysis was conducted. The results obtained confirm that the dependent variables of all models positively correlate with the independent variables, indicating a moderate to strong positive relationship, which justifies the conduct of the regression analysis. Also, the correlation analysis determined that there is a very strong positive correlation between the independent variables and that using multiple regression, the results obtained would be unreliable due to the problem of multicollinearity, and a simple regression analysis was used.

The basic regression model confirmed that there is a positive and statistically significant relationship between the logarithmic value of the company's expected growth rate in the five-year period and research and development expenditures from the previous three periods (2022, 2023 and 2024), and that the intensity of this relationship weakens as we move towards older time periods. The statistical relationship is significant with a 5% error margin for 2024 and 2023, while for 2022, it is significant with a 10% error margin. Based on the described results, we can not reject the basic research hypothesis, which posits a statistically significant positive relationship between investment in research and development and the value of companies in the technology sector. These results are consistent with research by Hall and Oriani (2006) and O'Mahony and Vecchi (2009), who find that investments in research and development have a positive effect on firm value, especially in technology-intensive industries.

The results of the regression and correlation analysis confirm that there is a positive relationship between the rate of return on assets from 2024 and research and development expenditures from the previous three periods (2024, 2023 and 2022). The intensity of this connection is strongest with research and development expenditures from 2023, while it is weakest with research and development expenditures from 2024. This relationship is statistically significant at a 0.05 error level for the year 2023, while the relationship for 2022 is statistically significant at an error level of 0.10. The relationship between the dependent and independent variables from 2024 is not statistically significant. Based on the obtained results, we can say that research and development expenditures from the current year do not have a statistically significant impact on the rate of return on assets, while expenditures from earlier periods do, with a note that the highest impact of expenditures from period t-1 on the rate of return on assets is in period t. Considering all the obtained results, we cannot reject the first auxiliary research hypothesis, which is that higher investments in research and development are positively related to the return on assets of companies in the technology sector. The obtained findings are in accordance with Park et al. (2019), who emphasize that the effects of R&D investments often become visible only with a delay, which is also confirmed by our results where expenditures from the previous period have the greatest influence. Similarly, He and Estebanez (2024) show that R&D investments in the current year have a weaker or insignificant impact on ROA, whereas the effects of previous years manifest themselves more significantly.

The smallest correlation is present between the rate of return on capital from 2024 and research and development expenditures from the previous three periods (2024, 2023 and 2022). In this regression model, the relationship is statistically significant only with expenditures from period t-1, with an error level of 10%. Other years do not have a statistically significant impact on the rate of return on capital from 2024. Due to the above, it can be concluded that the second auxiliary hypothesis is rejected and we say that we cannot prove that higher investments in research and development are positively related to the return on capital of companies in the technology sector. These findings are partially consistent with Chan, Lakonishok and Sougiannis (2001), who state that R&D investments

can generate positive long-term effects, which may limit short-term profitability measured by return on capital. Similarly, Billings et al. (1994) point out that high R&D costs can lead to weaker financial results in the short term.

The main limitation of this study is the very small sample size (N = 14), which reduces statistical power and increases coefficient instability. In addition, the DCF measure relies on simplified assumptions regarding future cash flows. The models include only one explanatory variable, and no control variables could be added without overfitting. Given the small sample size, the findings should be interpreted as exploratory associations.

4. Conclusion

According to the conducted research, it can be concluded that there is a statistically significant positive relationship between investment in research and development and the value of companies in the technology sector. The most pronounced effect was recorded in year *t*, while in the earlier observed periods, a decrease in the intensity of this effect was observed. The obtained results indicate that the value of the company grows proportionally to the increase in research and development expenditures, which aligns with the findings of other authors who have examined this relationship in different markets.

The analyses suggest a positive association between R&D expenditures and firm value and performance indicators, although these results should be interpreted with caution due to methodological limitations. Expenditures from previous years had a stronger impact compared to allocations from the current year, confirming the importance of continuous and long-term investment in research and development.

On the other hand, the results did not show the same level of connection with return on capital. A statistically significant relationship was identified only for allocations from the previous period (*t-1*), so the positive impact of investment in research and development on the return on capital in the technology sector cannot be fully confirmed.

The business implications of these findings suggest that companies should pay particular attention to the development of long-term R&D strategies to enhance competitiveness and achieve sustainable financial results. However, the research has its limitations. The lack of a qualified workforce can reduce the company's capacity for innovation, while the limited availability of informative balance sheets makes precise and comprehensive analysis of financial performance difficult.

Recommendations for future research include a comparison with companies from the region and the member states of the European Union, which would facilitate a deeper understanding of the similarities and differences in the effects of R&D investments. Also, the research could be expanded by introducing additional independent variables, such as the number of new applications and software solutions, employment in R&D departments, or other indicators, as well as by analyzing long-term trends. In this way, it is possible to gain a more comprehensive understanding of the complex impact of investments in research and development on the value of companies in the technology sector.

Declarations

The author has no relevant financial or non-financial interests to disclose. The data are available upon a reasonable request from the author.

References

Abdel Razaq, A., Freihat, F., & Kanakriyah, R. (2017). The impact of R&D expenditure on firm performance: Evidence from Jordanian pharmaceutical companies. *International Journal of Economics and Finance, 9*(2), 45–57.

Arnaut, E., & Jerković, D. (2017). Utjecaj sektora informacionih tehnologija na ekonomski razvoj Bosne i Hercegovine. *Tranzicija, 19*(40), 64–81.

Billings, B. K., Buse, R., & White, M. A. (1994). The impact of R&D spending on firm performance: An empirical investigation. *Journal of Business Finance & Accounting, 21*(7), 971–989.

Chan, L. K. C., Lakonishok, J., & Sougiannis, T. (2001). The stock market valuation of R&D expenditures. *Journal of Finance, 56*(6), 2431–2456.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152.

Damodaran, A. (2024). *Industry Beta Estimates*. Stern School of Business.

Daum, J. H. (2003). *Intangible assets and value creation*. John Wiley & Sons, Ltd.

Erickson, G. M., & Jacobson, R. (1992). Gaining competitive advantage through R&D strategy. *Management Science, 38*(3), 357–374.

Freihat, F., & Kanakriyah, R. (2017). Impact of R&D expenditure on financial performance: Jordanian evidence. *European Journal of Business and Management, 9*(32), 73–83.

Ghaffar, A., & Khan, M. (2014). Effects of R&D investment on firm performance. *Pakistan Journal of Commerce and Social Sciences, 8*(1), 1–8.

Griliches, Z. (1979). Issues in assessing the contribution of R&D to productivity growth. *Bell Journal of Economics, 10*(1), 92–116.

Hall, B. H. (1993). R&D tax policy during the 1980s: Success or failure? In A. J. Auerbach & M. Feldstein (Eds.), *Handbook of public economics* (Vol. 3, pp. 313–356). Amsterdam: Elsevier.

Hall, B. H. (1993). The stock market's valuation of R&D investment during the 1980s. *American Economic Review, 83*(2), 259–264.

Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the Economics of Innovation* (Vol. 1, pp. 609–639). Elsevier.

Hall, B. H., & Oriani, R. (2006). Does the market value R&D investment by European firms? Evidence from a panel of manufacturing firms in France, Germany, and Italy. *International Journal of Industrial Organization, 24*(5), 971–993. https://doi.org/10.1016/j.ijindorg.2005.12.001

He, X., & Estébanez, R. P. (2023). R&D investments and firm performance: Evidence from international technology companies. *Journal of Business Research, 158*, 113670. https://doi.org/10.1016/j.jbusres.2023.113670

Lev, B. (2001). *Intangibles: Management, measurement, and reporting*. Washington, DC: Brookings Institution Press.

O'Mahony, M., & Vecchi, M. (2009). R&D, knowledge spillovers and company productivity performance. *Research Policy, 38*(1), 35–44. https://doi.org/10.1016/j.respol.2008.09.003

OECD. (2015). Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development. OECD Publishing.

Palepu, K. G., Healy, P. M., & Peek, E. (1996). *Business Analysis and Valuation: IFRS Edition* (6th ed.). Cengage Learning.

Park, S., Kim, H., & Lee, J. (2019). R&D investment and firm growth. *Technology Analysis & Strategic Management, 31*(6), 668–681.

Sokolov-Mladenović, S., Cvetanović, S., & Mladenović, I. (2016). R&D expenditure and economic

growth: EU28 evidence for the period 2002–2012. *Economic Research – Ekonomska istraživanja, 29*(1), 1005–1020.

Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics, 39*(3), 312–320.

Wang, C.-H. (2011). The impact of resource-based factors on firm performance: Evidence from high-tech firms. *International Journal of Management, 28*(3), 1012–1027.