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HOW DO R&D INVESTMENTS MATTER FOR FINANCIAL AND SUSTAINABLE PERFORMANCE?

Ján Užík
PhD in Economics, Associate Professor of Accounting and Auditing, Bratislava University of Economics and Business, Bratislava, Slovakia;
ORCID: 0000-0001-6678-2285

Serhii Lehenchuk
D.Sc. in Economics, Professor of the Department of Information Systems in Management and Accounting, Zhytomyr Polytechnic State University, Zhytomyr, Ukraine;
e-mail: legenchyk2014@gmail.com
ORCID: 0000-0002-3975-1210
(Corresponding author)

Nina Poyda-Nosyk
D.Sc. in Economics, Professor of the Department of Accounting and Auditing, Ferenc Rakoczi II, Transcarpathian Hungarian College of Higher Education, Beregove, Ukraine;
ORCID: 0000-0002-5378-8028

Tetiana Ostapchuk
D.Sc. in Economics, Professor of the Department of Management, Business and Marketing Technologies, Zhytomyr Polytechnic State University, Zhytomyr, Ukraine;
ORCID: 0000-0001-9623-0481

Tetiana Tsalko
Candidate of Economic Sciences, Associate Professor of the Department of Management and Smart Innovations, Kyiv National University of Technologies and Design, Kyiv, Ukraine;
ORCID: 0000-0002-4609-8846

Svitlana Nevmerzhytska
Candidate of Technical Sciences, Associate Professor of the Department of Management and Smart Innovations, Kyiv National University of Technologies and Design, Kyiv, Ukraine;
ORCID: 0000-0001-5392-9030

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ABSTRACT

The paper aims to analyze whether R&D investments affect the financial and sustainable performance of innovative companies. For the regression analysis of the impact of R&D investments on financial and sustainable indicators, two types of models were used – the FinPerf and SustPerf models. These models consider both current and deferred R&D costs and R&D intensity, making it possible to build 24 analytical models. Based on data from 244 Western European innovative companies for 2021–2023, it was found that R&D spending has a short-term positive impact on ROA, ROE, and ROCE, but its effect disappears after one year. In turn, R&D intensity shows a negative impact on financial performance, which is explained by excessive innovation costs and their low efficiency. In the context of sustainable development, R&D investments positively affect corporate governance and the overall ESG score, but their effect is also limited to 1-2 years. At the same time, high R&D intensity worsens sustainable performance, especially in the environmental and government areas, indicating a conflict between innovation and sustainable development goals. Large innovative companies demonstrate better sustainable performance due to their large resources and standardized practices. The results confirm the need to ensure a balance between the volume of R&D investments and their quality, as well as the need to integrate innovation strategies with sustainability practices.

Keywords: financial performance, sustainable performance, R&D investments, R&D intensity, ESG score, sustainable development, innovative companies

JEL Classification: G30, L25, O32, Q55

INTRODUCTION

The basic principles of the theory of innovative development regarding R&D investments as one of the main factors ensuring long-term economic growth are becoming even more important in the context of intensifying global competition. The growing fierce competition between European companies, as leaders in the innovation sector, and American and Asian companies necessitates finding ways to develop their innovation activities to maintain competitiveness by developing more effective innovation practices and strategies.

For European companies, R&D investments are becoming not only a source of added value but also a tool for achieving the EU's technological sovereignty in the face of growing geopolitical risks. In this context, effective management of companies' innovation activities should be seen as a tool for ensuring their strategic flexibility and resilience, thereby reducing the EU's vulnerability to global crises.

On the other hand, the EU is actively formulating "new rules for sustainable development", compliance with which by innovative enterprises is becoming increasingly important for investors and market regulators. When assessing the investment attractiveness of companies, investors are increasingly paying attention not only to the financial prospects of innovations but also to the role that the company and its innovative products play in the formation of a society functioning on the principles of sustainable development. Therefore, European companies must not only ensure high innovative efficiency through the development of their innovative activities, increasing the commer-

cialization of created innovative products, but also adapt to the modern economic environment, functioning under new rules aimed at achieving sustainable development goals.

This suggests the need to analyze the financial and sustainable effects of R&D investments to find out how the institutional and economic conditions of the EU influence their emergence for innovative companies. This study focuses on the gap in understanding how R&D investments affect financial and sustainable performance, helping to improve decision-making regarding investments in EU innovative companies.

LITERATURE REVIEW

Research into the impact of R&D on financial and sustainable performance highlights the complex relationship between innovation, economic performance, and ESG indicators. This issue is particularly relevant for European companies in the context of promoting the European Green Deal and Europe's Digital Decade, which sees R&D as the foundation of the transition to sustainable development, and as a result of the EU's incentives to invest in innovation to improve the competitiveness and resilience of European companies. Therefore, in recent years, this issue has received much attention from scientists who have significant institutional support thanks to European research programs and projects. In addition, there is growing interest from academic, commercial, and policy circles in the impact of R&D expenditure on sectors and firms (Özkan, 2022).

Many publications in this area analyze companies in high-tech industries (IT, electronics, pharmaceuticals, biotechnology, automotive, industrial manufacturing, etc.), where R&D investments are a significant factor in value creation. Thus, Zhu and Huang (2012) found a significant correlation between R&D intensity (R&D/Revenue) and ROA for 73 Chinese listed IT firms for the 2007–2009 period, while Janjić, Krstić, and Milanović (2022) refuted it for high-technology companies for the 2012–2019 period. Dave et al. (2013) examined the impact of R&D on the ROA of S&P 500 IT companies. They found that ROA strongly correlates with R&D intensity, and R&D expenditure positively affects sales revenues, but hurts technology performance (Sales/Non-current assets). He and Estébanez (2023), in their analysis of 1,262 SMEs in the ICT services industry in China between 2011 and 2020, also found a significant positive effect of R&D on ROA and ROE, but a negative impact of Size on these two dependent variables.

Khan et al. (2023), using various correlation analysis methods (OLS, FEM, and GMM) for Chinese listed companies from 2000 to 2020, found a negative impact of R&D on corporate performance (ROA and ROE), and such an impact was less pronounced for state-owned enterprises. These findings confirm the results of the study by Janjić, Krstić, and Milanović (2022) on the negative impact of R&D investments on ROA for high-technology companies, as well as the findings of Yang et al. (2009), who, based on the use of the S-curve model in a study of 377 publicly listed Taiwanese high-tech manufacturing firms for 2000–2007, found a negative relationship between R&D intensity and company performance, and at the same time contradict the findings of Dave et al. (2013).

Many scientists have studied the relationship between R&D and the financial performance of pharmaceutical companies, since this industry is also one of the most knowledge-intensive. Thus, Pal and Nandy (2019) studied the impact of R&D on ROA and ROE of 37 Indian listed pharmaceutical companies from 1995 to 2015 and found it to be positive; they also found a negative effect of Leverage on ROE. In a further study of listed Indian pharmaceutical companies during 1999–2020, Nandy (2021) found a significant positive relationship between financial performance measures – Sales Turnover, ROA, ROE, Market Capitalization, and R&D – and that Leverage negatively affected Sales Turnover and ROE. Asad and Homolka (2023) conducted a similar study for European pharmaceutical companies. They found a positive association between the previous year's R&D expenditure and the current year's operating profit. Rahman and Howlader (2022) also found a significant positive association between R&D expenses and financial performance (ROA and ROE) for Bangladeshi pharmaceutical companies.

The activities of the most knowledge-intensive companies operating in a particular country also attract significant attention from researchers. Thus, Ravšelj and Aristovnik (2020) analyzed the features of the impact of R&D expenses on corporate performance (ROA, ROE, and ROS) of 3,399 Slovenian and 5,100 world R&D companies for the period 2012–2016 and found its absence in the short term and the presence of a positive impact for lagged variables of R&D intensity. The authors also found a positive effect of Size on ROA, ROE, and ROS. Özkan (2021) found similar results regarding the negative impact of R&D on ROA, ROE, and ROS, and the positive effect of Size on ROA and ROS for the 500 largest industrial companies in Turkey. Santos, Bandeira, and Ramos (2024), based on a study of the impact of R&D investment on the ROA of Portuguese innovative firms over the period 2012–2019, found no significant short-run impact but a significant negative impact of leverage.

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A number of researchers note the existence of an indirect influence of R&D investments on financial performance, which changes (in one direction or another) with the growth of such investments. Thus, Qi and Deng (2019) discovered a U-shaped relationship between R&D investment and company financial performance for Chinese listed A-share companies for 2007–2016, while Lehenchuk et al. (2022) found a curvilinear (inverted U) relationship between R&D and ROA for Slovak medical device companies for 2015–2019.

An analysis of scholarly opinions confirms the findings that the impact of R&D on financial performance is characterized by mixed results (Yang et al., 2009; Dave et al., 2013; Zhelev, 2024), or such findings are still inconclusive (Khan et al., 2023), that is, they reflect both direct positive and negative, as well as indirect (distorted) relationships between R&D and corporate value for companies from different sectors of the economy. The ambiguity of the authors' findings characterizing the role of R&D investments in ensuring financial performance necessitates a more thorough analysis in this research area.

Compared with the impact of R&D on financial performance, the effect of R&D on sustainable performance has received much less attention from scholars (Zhang et al., 2022; Dicuonzo et al., 2022; Fafaliou et al., 2024). As a result, the authors highlight the insufficiency of such studies to address sustainable development issues (Sempere-Ripoll et al., 2020), which may be due to the following reasons: 1) Currently, there is no single approach to calculating sustainable performance; 2) Scientists simultaneously use other similar indicators that characterize the effectiveness of an enterprise in achieving its sustainable development goals – ESG performance, sustainability development, and environmental performance, which limits the comparability of the results of such studies; 3) There is no single, generally accepted model for the formation of reporting indicators on the results of an enterprise's activities to achieve sustainable development goals (integrated, non-financial, and sustainability reports); 4) The impossibility of taking into account all aspects of R&D based on the limitations of the accounting system for measuring their impact on sustainable development indicators. At the same time, some scientists are trying to analyze the role of R&D both in ensuring overall sustainable performance and in relation to its more detailed components (environmental, social, and governmental performance).

Thus, Sempere-Ripoll et al. (2020), having analyzed a sample of 1,574 financial sector firms for 2012–2014 from 11 countries in Central and Eastern Europe, found a positive impact of innovations (product, process, organizational, and marketing) on corporate sustainability. The authors found that the most innovative companies were also those with a higher sustainability orientation.

Dicuonzo et al. (2022), examining the impact of R&D on ESG practices of industrial companies in France, Germany, Italy, Spain, the UK, and the US using regression analysis, found a positive and significant relationship between ESG practices and innovation. Companies that invest more in R&D have better ESG performance. This finding supports the findings of Drempetic, Klein, and Zwergel (2019), who found that firm size is positively correlated with a company's ESG performance.

Zhang et al. (2022) analyzed the role of innovation in the sustainable performance of SMEs listed on the Shanghai and Shenzhen stock markets from 2010 to 2017. The authors found that R&D is positively related to social and environmental performance, and that effective innovation can indirectly increase SMEs' ROA through social performance, whereas environmental performance does not. Ownership type also plays an important role in moderating the relationship between innovation and economic performance.

Aulia and Hambali (2023), studying the performance of 423 companies listed on the Indonesian Stock Exchange from 2013 to 2022 using the GLS fixed effect regression method, found that the level of a company's innovation, as well as the control variables of Size and Leverage, have a positive impact on sustainability performance.

Fafaliou et al. (2024) analyzed the performance of US companies for the period 2007–2016 and found the decisive role of innovations (their quantity and value) in achieving corporate sustainability, which is especially strengthened during times of recession. To analyze the impact of innovations, the R&D/Total assets (%) and Patents/Total assets (%) indicators were used, in relation to which a positive and significant impact on ESG was revealed, as well as its components – EP and GP for the first indicator, and EP, SP, and GP for the second.

Some scholars pay attention to the impact of R&D on companies' environmental performance. Thus, Kabongo and Okpara (2013), based on the analysis of a large sample of US firms for 1991–2009, showed a positive impact of R&D intensity on negative environmental externalities resulting from manufacturing activities, confirming the positive role of R&D investments in overcoming environmental problems. Fernández, López, and Blanco (2017) investigated the impact of innovation on reducing CO2 emissions using the example of companies from the EU (15 countries), the USA, and China for 1990–2013 and found that R&D has a positive impact on this process. Alam et al. (2018) conducted a similar study by analyzing panel data of 1,350 enterprises from G-6 countries for 2004–2016 and found that investment in R&D scaled by sales turnover has a significant negative impact on energy consumption and carbon intensity, which leads to energy efficiency. The same negative impact was found for Size, and an inverse relationship was found for the effect of Leverage.

Some scientists also examine the role of purely sustainable or green R&D investments in improving sustainable performance. Thus, Anqi et al. (2023) found a significant positive impact of green R&D investment on ESG performance based on a regression analysis of the performance of Chinese A-share companies for the period 2016–2021. The larger the company size, the greater its impact on ESG performance. Similar findings regarding the positive impact of green innovation on ESG performance were also obtained by Wu and Li (2023), who studied 2,707 companies listed in China A-shares during the period 2010–2021. Such studies confirm the significant role of sustainable innovations in the efficient use of resources, optimization of production processes, and development of environmentally friendly technologies that ensure improved sustainable performance.

Thus, most scientists note that R&D investments contribute to more efficient use of companies' resources, which reduces the negative impact on the environment, ensuring the achievement of sustainable development goals. At the same time, there is no clear answer to the question of whether companies with the most active innovation policies are focused on achieving sustainable development goals or not.

Given these considerations, which often view innovation as a self-evident positive factor for organizations (Liao & Rice, 2009), the following research hypotheses are tested:

- **H1.** R&D investment, measured by R&D costs and R&D intensity, positively impacts financial performance in companies with active innovation policies.
- **H2.** R&D investment, measured by R&D costs and R&D intensity, positively impacts sustainable performance in companies with active innovation policies.

Based on the literature review and analysis of hypotheses (H1 and H2), a conceptual model was developed to study the impact of R&D investments on financial and sustainable performance (Figure 1).

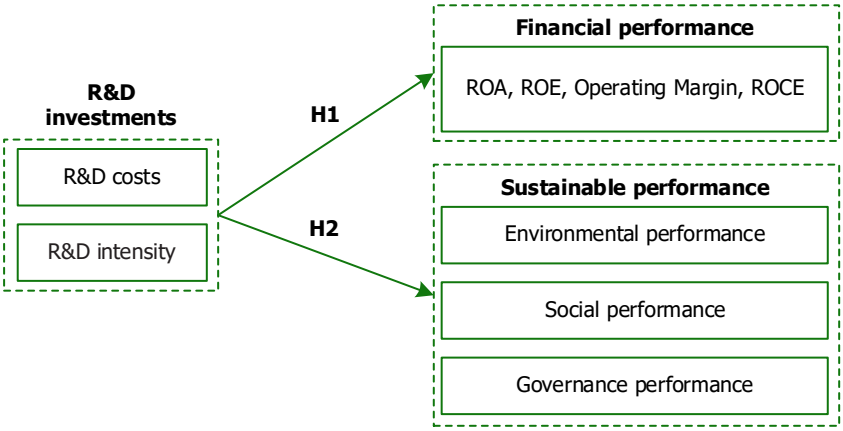

Figure 1. Conceptual model of the study.

AIMS AND OBJECTIVES

This study aims to analyze whether R&D investments affect innovative firms' financial and sustainable performance.

METHODS

Ordinary least squares (OLS) regression analysis served as the main methodological basis for this study. This approach allows us to examine the relationship between dependent variables (determinants) and independent variables that capture the outcome of interest. The dependent variables covered a set of financial and sustainable performance indicators (measures), while the independent variables included measures of R&D investment in European firms. Control variables were introduced to mitigate potential confounding effects and improve the robustness of the model estimates.

The sample under study included the top 300 Western European companies with the largest R&D costs in 2023, as a result of which they can be considered the most innovative and active. The Orbis database was used to obtain information about the results of their innovation activities and their financial performance measures for 2019–2023. To determine the sustainable performance measures of Western European companies, as in the work of Krasodomska et al. (2025), LSEG ESG Scores developed by LSEG, a provider of financial infrastructure and data, were used. Given the lack of LSEG ESG Scores

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for all selected top 300 Western European companies, the final sample included 244 innovation-active companies.

Table 1 presents the industrial sub-sectors according to the BvD classification included in the study, their NACE Codes, and the number of innovatively active Western European companies for 2023.

Table 1. R&D investments for 2023 within the Industrial Sub-Sectors Categorized by BvD and NACE Rev. 2 Codes (sub-sector averages, USD).

BvD Sub-Sectors	NACE Codes	Number of companies	Average sub-sectoral R&D costs	Average sub-sectoral R&D Intensity
Agriculture, Horticulture & Livestock	111	1	341447	17.08
Banking, Insurance & Financial Services	6499, 6430	3	1823677.7	7.2
Biotechnology and Life Sciences	7211	1	1110205.0	45.45
Business Services	6420, 7490, 8020, 7311, 7010, 7112, 6209	11	698756.9	7.6
Chemicals, Petroleum, Rubber & Plastic	2120, 2211, 2030, 2042, 2052, 2059, 2060, 2222, 2229	58	1389050.4	11.3
Communications	2630, 2640, 6190	10	1292764.2	19.3
Computer Hardware	2620	2	242650.5	10.52
Computer Software	6201, 6311, 5829	4	146568.5	13.53
Food & Tobacco Manufacturing	1107, 1089, 1200, 1101, 1081	5	536311.4	1.42
Industrial, Electric & Electronic Machinery	5829, 2790, 2611, 2651, 2830, 5829	80	608942.59	7.00
Leather, Stone, Clay & Glass products	2351, 2319, 2343	6	118046.7	3.3
Media & Broadcasting	6209, 5911	2	1023230.5	7.1
Metals & Metal Products	2410, 2434, 2511, 2512, 2599, 2815,	13	191877	2.59
Mining & Extraction	610, 729	5	369617.2	1.7
Miscellaneous Manufacturing	3230, 3212	2	97822	0.715
Public Administration, Education, Health, Social Services	8690	2	1026626	4.91
Retail	4771	1	82323.00	0.73
Textiles & Clothing Manufacturing	1413, 1512, 1520	3	142788.3	1.98
Transport Manufacturing	8412, 2910, 2920, 2932, 3020, 3030	26	2549900.1	5.5
Transport, Freight & Storage	5229, 4941	2	196565	2.11
Travel, Personal & Leisure	9329	1	974265.00	6.49
Utilities	3513	1	179809.00	9.16
Wholesale	4614, 4652, 4674, 4690	5	151400.4	7.062
Total / Average	-	244	979625.13	8.00

An analysis of R&D investment data for 2023 within the Industrial Sub-Sectors (Table 1) showed that the highest absolute R&D costs among the companies in the sample are in Transport Manufacturing, Banking, Insurance & Financial Services, Chemicals, Petroleum, Rubber & Plastic, Biotechnology, and Life Sciences. At the same time, the most knowledge-intensive industries are Biotechnology and Life Sciences, Communications & Agriculture, and Horticulture & Livestock, where the R&D Intensity indicator is 45.45%, 19.3%, and 17.08%, respectively. Low priority for R&D investments is characteristic of Miscellaneous Manufacturing (0.715%), Retail (0.73%), and Mining & Extraction (1.7%), which have the lowest R&D

Intensity indicators. In general, high-tech industries (biotech, communications, chemicals) show significant R&D investments, confirming their innovation-driven nature. Traditional manufacturing sectors (metals, textiles, and food processing) exhibit low R&D intensity, suggesting a focus on operational efficiency rather than innovation. The financial sector reports high absolute R&D spending (USD 1.82 million), likely due to investments in fintech and digital technologies of Industry 4.0.

The analysis of the dynamics of R&D investments of the studied Western European companies for 2021–2023 shows that the absolute volume of R&D costs is constantly growing. At the same time, the R&D Intensity indicator decreased in 2022 compared to 2021, and increased again in 2023, exceeding the 2021 value (Figures 2 and 3). The decrease in R&D Intensity can be explained by the increasing economic uncertainty due to Russia's attack on Ukraine in 2022. This has caused many companies to reduce investments due to risks, rising energy prices, and supply chains. Its rise in 2023 is a consequence of gradual adaptation to new economic conditions, expectations of market resumption, and the establishment of technological trends that made it possible to return to the full implementation of previously developed innovative strategies.

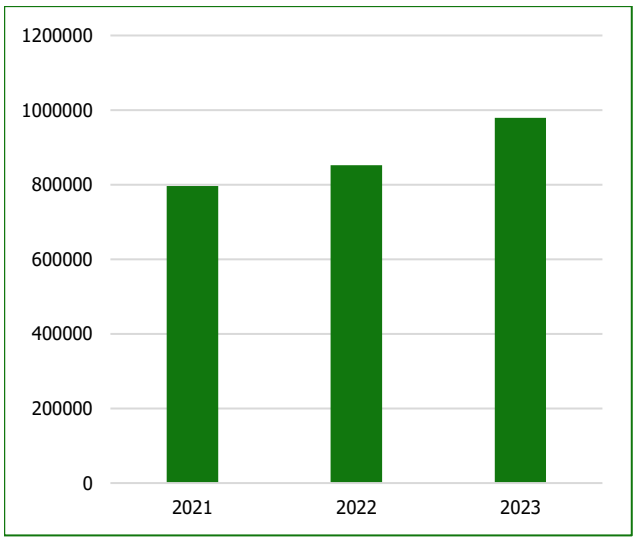

Figure 2. Dynamics of absolute R&D costs of the studied companies for 2021–2023 (USD)

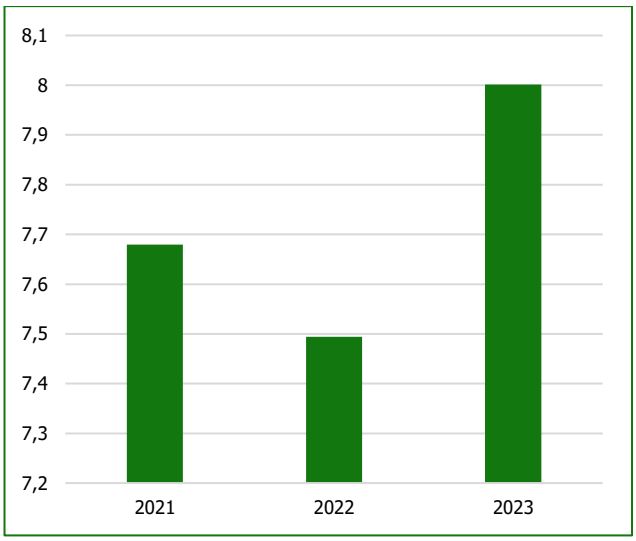

Figure 3. Dynamics of the R&D intensity indicator of the studied companies for 2021–2023

The following dependent variables were used to characterize the financial performance of agricultural companies: Return on Assets, Return on Equity, Operating Margin, and Return on Capital Employed. To characterize sustainable performance, the ESG score, Environmental pillar score, Social pillar score, and Governance pillar score were used, calculated based on the LSEG methodology. It is based on the LSEG ESG materiality matrix, more than 750 ESG metrics, and 186 comparable measures to form indicators across environmental, social, and governance categories.

R&D costs and R&D intensity, which are widely used by scientists to represent their innovation levels (Özkan, 2022), were used as independent variables characterizing the R&D investments of Western European companies. Given the potential time lag between the implementation of R&D costs and their impact on performance, the study applied lagged values of the R&D costs and R&D intensity variables. This approach is consistent with the methodology of previous studies (Ravšelj & Aristovnik, 2020; Özkan, 2022; He & Estébanez, 2023) and allows for a more accurate assessment of the long-term effect of companies' innovation activities.

Based on Alam et al. (2018), Zhang et al. (2022), Raboshuk et al. (2023), Aulia and Hambali (2023), and Lehenchuk et al. (2024), the study used Leverage and Size as control variables. The Size indicator was logarithmically transformed to align with the methodological approach adopted in prior studies (Özkan, 2022; Serpeninova et al., 2024). The regression model control variables also include three dummy variables that reflect: the company’s independence level, entity type, and organizational and legal form. The inclusion of these variables is methodologically justified by increasing the level of control over the heterogeneity of the sample, since different levels of independence of companies and their organizational and legal forms can significantly affect their innovative activities and financial results, as well as the need to eliminate bias caused by omitted variables.

Types of selected variables, their calculation procedure, and abbreviations used in study variables are shown in Table 2.

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Table 2. Summary of all dependent, independent, and control variables, their definitions, calculation procedure, and abbreviations.

Variable	Calculation procedure	Abbreviation
Dependent Variables		
Return on Assets	Net Turnover / Total Assets	ROA
Return on Equity	Profit / Total Equity	ROE
Operating Margin	EBIT / Sales	EBITm
Return on Capital Employed	Net Income / (Shareholders' funds + non-current liabilities)	ROCE
ESG score	Relative sum of the category weights, which vary per industry for the environmental, social, and governance categories, calculated based on the LSEG methodology	ESG
Environmental pillar score	Estimation of a company's environmental performance based on its actions to reduce its environmental impact, calculated via the LSEG methodology	E
Social pillar score	Estimation of the company's social impact on employees, customers, and society, calculated based on the LSEG methodology	S
Governance pillar score	Estimation of the quality of corporate governance, transparency, and ethical standards, calculated based on the LSEG methodology	G
Independent Variables		
R&D costs	Sum of R&D expenses for the reporting period	RDt
R&D intensity	R&D expenses / Operating revenue	RDIt
Control Variables		
Leverage	Total Debts / Total Assets	Lev
Size	Logarithm of Total Assets	l_Size
Dummy variable for independence	1 if the company is fully independent, 0 if it is not	Dum_Ind
Dummy variable for entity type	1 if the company is a controlled subsidiary, 0 – if Global Ultimate Owner	Dum_T
Dummy variable for legal form	1 if the company is a Public limited company, 0 – if a Private limited company	Dum_LF

To understand the impact of R&D investments on the financial and sustainable performance of Western European companies, this study examined two types of models:

FinPerf Models:

$$DVFP_{it} = \alpha + \beta_1 \text{ R\&D costs}_{it} + \beta_2 \text{ R\&D intensity}_{it} + \beta_3 Lev_{it} + \beta_4 l\_Size_{it} + \beta_5 Dum\_Indep_{it} + \beta_6 Dum\_Type_{it} + \beta_7 Dum\_LegForm_{it} + \varepsilon_{it} \quad (1)$$

SustPerf Models:

$$DVSP_{it} = \alpha + \beta_1 \text{ R\&D costs}_{it} + \beta_2 \text{ R\&D intensity}_{it} + \beta_3 Lev_{it} + \beta_4 l\_Size_{it} + \beta_5 Dum\_Indep_{it} + \beta_6 Dum\_Type_{it} + \beta_7 Dum\_LegForm_{it} + \varepsilon_{it} \quad (2)$$

where: DVFP – dependent variables that characterize financial performance (ROA, ROE, EBITm, and ROCE), where $_i$ = entity and $_t$ = time; DVSP – dependent variables that characterize sustainable performance (ESG, E, S, G), where $_i$ = entity and $_t$ = time; α – Identifier; μ – Variance introduced by the unit-specific effect for unit $_i$; β – Regression coefficient; R&D costs, R&D intensity – independent variables; Lev, l_Size, Dum_Indep, Dum_Type, Dum_LegForm – control variables, where $_i$ = entity and $_t$ = time; ε_{it} – error term.

The first type model (FinPerf) is used to test H1 using various types of financial performance measures, while the second type model (SustPerf) is used to test H2 using both the general characteristic of sustainable performance and its three separate components. Based on these two types, 8 main models have been formed that allow us to determine how R&D investments of the current year (RD_t and RDI_t) influence various types of financial and sustainable performance measures, as well as the strength and direction of such influence. Two auxiliary models were constructed for each of the main models, which allow analyzing the impact of lagged R&D investments (RD_{t-1}, RDI_{t-1}, RD_{t-2}, and RDI_{t-2}) on the same dependent variables.

RESULTS

Table 3 presents descriptive statistics for all variables from the 24 models analyzed.

Table 3. Descriptive statistics (based on observations: 1-244). *(Source: calculated by authors using the GRETL software package)*

Variables	Observation	Mean	Median	St. Dev.	Minimum	Maximum
ROA	244	5.28	5.29	8.61	-73.0	41.3
ROE	244	16.7	15.3	29.2	-242.	176.
EBITm	244	10.3	10.6	13.0	-91.0	44.0
ROCE	244	9.68	8.67	13.4	-83.1	118.
ESG	244	69.5	71.0	13.6	18.0	95.0
E	244	68.1	70.0	19.3	0.000	98.0
S	244	75.4	77.0	14.2	13.0	97.0
G	244	62.3	64.5	20.4	7.00	96.0
RD_t	244	979625.14	192823.50	2290885.51	52759.00	18334168.00
RD_{t-1}	244	852526.95	133221.00	2048922.19	881.00	15503926.00
RD_{t-2}	244	796769.70	158312.50	1830049.59	499.00	15284322.00
RDI_t	244	8.00	4.76	9.03	0.310	63.6
RDI_{t-1}	244	7.49	4.66	8.49	0.280	70.3
RDI_{t-2}	244	7.68	4.55	8.81	0.290	72.2
Lev	244	43.7	43.3	15.4	7.53	89.6
l_Size	244	15.9	15.9	1.73	9.10	20.3

The calculation of descriptive statistics for the sample of 244 innovative enterprises (Table 3) revealed significant characteristics of the studied population. The uniform observation count (N = 244) for all variables indicates that the study used a balanced dataset.

An analysis of the results of calculating the descriptive statistics indicators allowed us to establish that since all financial performance measures (ROA, ROE, EBITm, and ROCE) are characterized by a large spread of data, this indicates the variability of the financial performance of the companies under study. In particular, negative minimum values of ROA (-73), ROE (-242), EBITm (-91), and ROCE (-83.1) show that some innovative companies are extremely unprofitable, which indicates the presence of critical problems in managing their innovative activities. On the other hand, the presence of companies with high profitability measures indicates the opposite situation in innovation management. The high extreme values of ROE (-242 and 176) and the high standard deviation (29.2) confirm the presence of risky or highly efficient companies in the sample; the variability of EBITm, confirmed by its high standard deviation (13), and the unprofitability of individual companies (-91) indicate the presence of industry or management risks.

High average (69.5) and median (71.0) ESG scores indicate a relatively high level of compliance of innovative companies with the requirements aimed at achieving sustainable development goals. However, the large gap between the maximum and minimum values (18.0-95.0) highlights a significant difference between lagging and leading companies in terms of the quality of sustainability management. Since the S indicator has the highest average value (75.4), we can state the priority of social initiatives in implementing sustainability practices in the innovative companies under study.

The absence of a difference between the mean and median for financial and sustainable performance measures indicates a symmetric distribution without significant outliers and the homogeneity of the sample for these indicators. This suggests that companies generally demonstrate financial results close to the industry average, and there is no polarization between ESG leaders and laggards. On the other hand, such a difference between the RD_t and RDI_t intensity metrics in different years allowed us to identify a strongly skewed distribution, with only a few companies making disproportionately large R&D investments. Unlike RD_t and RDI_t, the average value of financial and sustainable performance measures is an adequate benchmark.

The average leverage value of 43.7% indicates a moderate use of debt capital by innovative companies, and the significant

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gap between its extreme values (7.53-89.6) indicates the presence of different strategies for financing their activities. Since the mean value of l_Size (15.9) is greater than its standard deviation (1.73), this indicates relatively homogeneous scaling among the sampled companies, suggesting that size acts as a stabilizing background characteristic rather than a primary differentiator in the analysis of R&D investment efficiency.

A correlation matrix was constructed using the GRETL software package to analyze the risk of multicollinearity of the regression model.

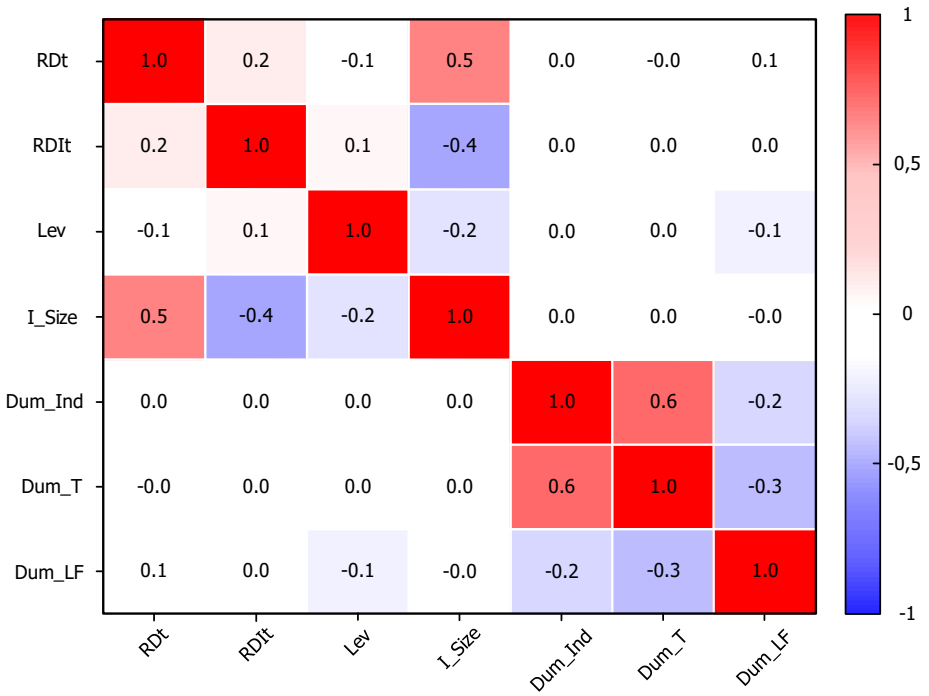

Figure 4. Correlation matrix of independent variables. *(Source: calculated by authors using the GRETL software package)*

The correlation matrix analysis of independent variables (Figure 4) did not reveal any signs of a serious multicollinearity problem among them, since all pairwise correlation coefficients fall below the critical threshold of |0.7|, with most of them demonstrating weak or moderate relationships (|r| < 0.5). The moderate negative correlation between RDI_t and l_Size (-0.4) indicates a tendency towards a decrease in R&D intensity for large innovative companies. This can be explained by both a lower share of R&D costs in operating expenses and savings on R&D costs due to the ready-made innovative infrastructure and personnel. The low correlation coefficient (0.0) between RDI_t and all dummy variables (Dum_Ind, Dum_T, and Dum_LF) indicates that independence, entity type, and legal form of innovative companies do not affect R&D intensity. Lev and l_Size are generally not key factors for R&D, indicating that other determinants of innovation play a significant role. To test the robustness of the relationships between R&D and financial and sustainable performance measures, it is appropriate to use the lagged variables RD_{t-1}, RD_{t-2}, RDI_{t-1}, and RDI_{t-2}. An analysis of the role of R&D investments in ensuring the financial performance of European innovative companies (Table 4) revealed that RD_t has a statistically significant positive impact, with varying degrees of significance, on ROA (0.0327), ROE (0.0463), and ROCE (0.0515). The lagged R&D costs (RD_{t-1} and RD_{t-2}) lose their significance; this indicates the short-term effect of R&D investments of the companies under study, which manifests itself mainly within one year. After this period, their statistical impact on financial performance measures (ROA, ROE, EBITm, and ROCE) becomes insignificant.

Table 4. Analyzed FinPerf Models (ROA (a, b, c), ROE (a, b, c), EBITm(a, b, c), ROCE(a, b, c)) and SustPerf Models (ESG(a, b, c), E(a, b, c), S(a, b, c), G(a, b, c)). OLS, using the observations: 1-244. Note: * Significant at the 10 % level; ** Significant at the 5 % level; *** Significant at the 1 % level. *(Source: calculated using the GRETL software package)*

Variables	FinPerf Models											
	ROA(a)	ROE(a)	EBITm(a)	ROCE(a)	ROA(b)	ROE(b)	EBITm(b)	ROCE(b)	ROA(c)	ROE(c)	EBITm(c)	ROCE(c)
Const	0.6513	0.2111	-0.6198	0.3578	-0.3999	0.9848	-0.1792	-0.7657	-0.4342	-0.8736	-0.2500	-0.7002
RD_t	0.0327**	0.0463**	0.1344	0.0515*	x	x	x	x	x	x	x	x
RD_{t-1}	x	x	x	x	0.2514	0.3334	0.5129	0.3334	x	x	x	x
RD_{t-2}	x	x	x	x	x	x	x	x	0.4107	0.5335	0.5102	0.4774
RDI_t	-0.0150**	-0.0162**	-0.0579*	-0.0058***	x	x	x	x	x	x	x	x
RDI_{t-1}	x	x	x	x	-0.0458**	-0.0317**	-0.1797	-0.0240**	x	x	x	x
RDI_{t-2}	x	x	x	x	x	x	x	x	-0.0115**	-0.0085***	-0.1677	-0.0060**
Lev	9.75×10^{-5}***	-0.9023	2.38×10^{-6}***	0.1007	0.0002***	-0.8287	3.36×10^{-6}***	0.1371	0.0002***	-0.8611	4.11×10^{-6}***	0.1291
l_Size	-0.0708*	-0.0793*	0.7923	-0.0359**	0.9607	-0.9952	0.2188	0.7862	0.8478	0.8652	0.3041	-0.9584
Dum_Ind	0.3455	-0.2534	-0.7350	-0.1994	-0.3840	-0.2881	-0.7478	-0.2326	0.3709	-0.2726	-0.7323	-0.2277
Dum_T	0.5513	0.7425	-0.6030	0.9222	0.7801	0.9529	-0.4690	-0.8620	0.7836	0.9477	-0.4715	-0.8541
Dum_LF	0.0059***	0.0115**	0.0373**	0.0278**	0.0079***	0.0157**	0.0393**	0.0321**	0.0086***	0.0172**	0.0420**	0.0329**
R-squared	0.264181	0.226179	0.227484	0.224632	0.177851	0.149732	0.176124	0.163480	0.159278	0.127197	0.171125	0.151001

Varia-bles	SustPerf Models											
	ESG(a)	E(a)	S(a)	G(a)	ESG(b)	E(b)	S(b)	G(b)	ESG(c)	E(c)	S(c)	G(c)
Const	-0.4055	-0.1382	0.9379	-0.7895	-0.6611	-0.1536	0.8294	0.7712	-0.7589	-0.1803	0.7112	0.7248
RD_t	0.0784*	0.1503	0.8920	0.0810*	x	x	x		x	x	x	x
RD_{t-1}	x	x	x	x	0.0097***	0.0664*	0.6180	0.0138**	x	x	x	x
RD_{t-2}	x	x	x	x	x	x	x	x	0.0015***	0.0247**	0.3795	0.0041***
RDI_t	-0.0807*	-0.0839*	-0.6788	-0.1982	x	x	x	x	X	x	x	x
RDI_{t-1}	x	x	x	x	-0.0078***	-0.0464**	-0.6049	-0.0142**	X	x	x	x
RDI_{t-2}	x	x	x	x	x	x	x	x	-0.0057***	-0.0269**	-0.4714	-0.0232**
Lev	0.6746	0.8293	0.8131	0.5949	0.7097	0.8715	0.8286	0.6147	0.6641	0.8206	0.8200	0.5777
l_Size	4.48×10^{-9}***	2.92×10^{-6}***	1.24×10^{-11}***	0.1554	4.00×10^{-9}***	1.33×10^{-6}***	7.07×10^{-12}***	0.4350	5.70×10^{-9}***	9.83×10^{-7}***	1.01×10^{-12}***	0.4985
Dum_Ind	0.3412	-0.9375	0.5751	0.2827	0.3019	0.9957	0.5773	0.2438	0.3021	0.9825	0.5785	0.2443
Dum_T	0.0014***	0.1639	0.9200	4.37×10^{-7}***	0.0015***	0.1787	0.9101	5.12×10^{-7}***	0.0015***	0.1789	0.9035	7.23×10^{-7}***
Dum_LF	0.0355**	0.0092***	0.4315	0.1110	0.0373**	0.0102**	0.4431	0.1143	0.0388**	0.0102**	0.4523	0.1188
R-squared	0.356483	0.290785	0.292452	0.207680	0.367424	0.295329	0.292906	0.223420	0.369943	0.297804	0.293814	0.224724

The revealed negative and significant impact of RDI_t on all financial performance measures (ROA, ROE, EBITm, and ROCE) indicates the presence of a counterintuitive relationship, which can be justified by the effect of excessive investments in R&D and their low market efficiency. The loss of influence of lagging R&D intensity indicators (RDI_{t-1} and RDI_{t-2}) means that it is not the volume of R&D investments that is important, but their quantitative ratio in relation to the revenue of the innovative company. Therefore, temporary injections of funds into R&D without proper strategic rethinking of their use are not sufficient to improve the companies' future profitability. Another reason for these results may be the obsolescence of innovations for companies in high-tech sectors, which make up the vast majority of the sample studied, resulting in past R&D investments not generating future revenues.

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An additional test of the hypothesis of the R&D optimal level, according to which there may be a U-shaped relationship between RDI_t and financial performance, by including a new regressor, RDI_t^2, in the studied models, did not yield positive results. The results regarding the positive significant impact of RD_t and the negative significant impact of RDI_t on financial performance measures simultaneously confirm and refute the proposed hypothesis H1 for various indicators characterizing R&D investments.

An analysis of the role of structural factors revealed that Lev significantly affects ROA (0.0001) and EBITm (0.0000024) with significance at the 1% level, but not ROE, which confirms the importance of the optimal capital structure used by innovative enterprises. Since Dum_LF has a significant positive impact on all financial performance measures, public companies have better financial performance.

l_Size significantly influences the three financial performance measures, ROA, ROE, and ROCE, only in the current period, but the effect is completely absent in the models with lagged variables (ROA(b), ROE(b), EBITm(b), ROCE(b), ROA(c), ROE(c), EBITm(c), and ROCE(c)), indicating a scale effect for innovation. This means that the advantages of large innovative companies are realized immediately, but do not have a long-term cumulative effect. Over time, other factors become more significant (quality of innovation management, market conditions, etc.), and the innovative advantages of large innovative companies are leveled by competitors or lose relevance. The presence of only a short-term significant positive effect of l_Size and a long-term significant negative effect of RDI_t highlights the importance of the quality of innovations and the need to update them regularly to ensure long-term benefits.

The decrease in the R^2 indicator from 22-26% to 15-17%, explained by the analyzed models for current and lagged R&D investment data, further confirms a short-term effect from innovation and the absence of an important role of past R&D investments in ensuring future financial performance.

R&D costs have a limited impact on overall and individual ESG indicators, in particular, the impact is significant and positive for ESG and G in all three types of SustPerf models (a, b, and c). In particular, current RD_t significantly positively affects ESG (0.0784) and G (0.0810) with significance at the 1% level, which indicates their significant role in improving the corporate governance of innovative companies. The analysis of the impact of the lagged variables RD_{t-1} and RD_{t-2} indicates a stronger and longer-term impact of R&D investments on ESG and G, which confirms the presence of a lag (1-2 years) in the impact of innovation on these ESG indicators.

As for the FinPerf Models, the SustPerf Models also showed significant negative effects of RDI_t, RDI_{t-1}, and RDI_{t-2} for individual dependent variables, specifically ESG, E, and G, which contradicts the positive effects of RD_t on ESG and G. The counterintuitive effect identified suggests that increasing the share of R&D expenditure in the operating income of innovative companies is detrimental to the ESG management system, in particular due to the inability of small and medium-sized companies to effectively integrate innovation and sustainable practices. As a result, there may be a shortage of resources for the successful implementation of sustainable practices, which may lead to energy costs, increased emissions, violation of ethical principles of corporate governance, etc., to achieve highly innovative results.

When using lagged variables, RDI_{t-1} and RDI_{t-2}, in SustPerf Models, we observe their significant negative impact on ESG, E, and G, and the level of such significance increases (from significance at the 10% level for the impact of RDI_t on ESG and E to significance at the 1% level for the impact of RDI_{t-1} and RDI_{t-2} on ESG and E). This indicates the accumulation of unresolved problems that negatively affect the implementation of sustainable practices of innovative companies, the preservation of their influence for 1-2 years, as well as the impossibility of fully adapting sustainable practices to R&D practices. Thus, the results obtained regarding the positive significant impact of RD_t and the negative significant impact of RDI_t on sustainable performance measures simultaneously confirm and refute the proposed H2 for various indicators characterizing R&D investments.

The analysis of the influence of control variables revealed that l_Size has a positive impact on ESG, E, and S with significance at the 1% level. This indicates that large innovative companies have a systemic advantage in achieving sustainable development goals. When using lagged variables RD_{t-1} and RD_{t-2}, l_Size acts as a stabilizing factor, characterizing the provision of high-quality sustainable practices at large innovative enterprises due to the larger volume of funding for sustainable initiatives and the high level of their standardization through corporate policies, codes, and standards.

A positive impact of Dum_T on ESG and G with significance at the 1% level was established, which confirms the implementation of more effective sustainable practices in innovative companies that are controlled subsidiaries. This may be a consequence of the strict requirements set by parent companies and standardized sustainable practices imposed from above. It was also found that public companies invest more in the implementation of environmental innovation initiatives, since Dum_LF has a significant positive effect on E (0.0355) and ESG (0.0092).

DISCUSSION

Many scholars have studied the impact of R&D investments on financial and sustainable performance. The literature review revealed the lack of clarity in such studies' results, as they found either a significant positive or negative impact of R&D investments, or a complete lack of such impact. This confirms the findings of Ahmad and Wu (2021) and Özkan (2022) about mixed results.

Based on the results of the study, hypotheses H1 and H2 regarding the influence of RD_t were partially confirmed, and they were also refuted when studying the influence of RDI_{t-1} and RDI_{t-2} on financial performance measures.

Thus, a positive impact of RD_t on ROA, ROE, and ROCE confirms the findings of He and Estébanez (2023), Janjić, Krstić, and Milanović (2022), and Rahman and Howlader (2022) on the benefits of R&D investments in the short run and points to their more significant role in driving financial performance specifically for innovative firms. The obtained results also contradict the results of Yang et al. (2009), Qi and Deng (2019), and Khan et al. (2023) regarding the significant negative effect of RD_t and positive effect of RD_{t-1} on financial performance measures. On the other hand, this study did not confirm the results of Rahman and Howlader (2022), Asad and Homolka (2023), and He and Estébanez (2023) on the positive role of RD_{t-1} in achieving the profitability of European companies, according to which there is a one-year delay in receiving benefits from R&D investments. Thus, increasing R&D investments does not lead to long-term growth in financial performance, but has a short-term effect.

The use of an additional regressor, RDI_t^2, in all the studied models did not confirm the findings of Yang et al. (2009), Qi and Deng (2019), and Lehenchuk et al. (2022) about the existence of a U-inverted relationship between RDI_t and financial performance measures.

The findings that RDI_t has a significant negative impact on financial performance measures (ROA, ROE, and ROCE) confirm and expand on the findings of Liao and Rice (2010), Dave et al. (2013), Ravšelj and Aristovnik (2020), and Özkan (2022) that the competitive advantages of R&D investments are manifested in the long term and are also due to their uncertainty and risky nature. At the same time, they contradict the findings of Pal and Nandy (2019) and Nandy (2021) that RDI_t has a positive effect on financial performance measures, the findings of Zhu and Huang (2012), Ravšelj and Aristovnik (2020), Özkan (2022), and Santos, Bandeira, and Ramos (2024) that lagging RDI_{t-1} has a significant positive effect on financial performance measures, and also confirm the results of Özkan (2022) that lagging RDI_{t-2} has a significant negative effect.

Thus, the study results show that active innovation policy can harm the financial and sustainable performance of innovative companies. Therefore, management should pay close attention not only to the volume of R&D investments but also to their qualitative content, which will ensure high efficiency of innovations, analysis of their role in the structure of the company's operating income, and their relationship with sustainable practices. The results also do not confirm that R&D investments bring benefits in lagged periods (one and two years), but, on the contrary, have a significant negative effect, demonstrating their inability to provide innovative results in the next three years after their implementation.

The significant positive relationship found between Leverage ratio and ROA for all three types of FinPerf models, in contrast to the findings of Pal and Nandy (2019), Qi and Deng (2019), Khan et al. (2023), and Santos, Bandeira, and Ramos (2024), confirms the importance of forming an optimal capital structure to achieve higher ROA. The significant negative impact of Size on ROA, ROE, and ROCE, confirming and expanding the findings of Qi and Deng (2019) and He and Estébanez (2023) and refuting the findings of Ravšelj and Aristovnik (2020), Özkan (2021), and Khan et al. (2023), indicates a decrease in the financial efficiency of companies' innovative activities with an increase in their volume.

The results obtained from examining the positive impact of RD_t, RD_{t-1}, and RD_{t-2} on ESG in all SustPerf models confirm the consensus reached in the literature (Sempere-Ripoll et al., 2020; Dicuonzo et al., 2022; Anqi et al., 2023; Wu & Li, 2023; Aulia & Hambali, 2023; Fafaliou et al., 2024) on the overall positive role of R&D investment in the sustainable performance of companies, which confirms hypothesis H2. At the same time, the identified negative impact of RDI_t, RDI_{t-1}, and RDI_{t-2} on ESG refutes hypothesis H2, shifting the focus from the volume of R&D investments to their ability to generate income.

The identified positive impact of RD_t on G confirms the findings of Fafaliou et al. (2024) on the existence of returns on R&D investments in the development of corporate governance practices in the short term, the impact of which will continue over the next two years. A contradiction has been found with the studies of scientists noting the positive role of R&D investments in overcoming environmental externalities and in solving environmental problems (Kabongo & Okpara, 2013; Fernández, López & Blanco, 2017; Alam et al., 2018; Zhang et al., 2022). The same situation is observed for the delayed effects of RDI_{t-1} and RDI_{t-2} on G. Moreover, this negative impact increases over the next two years, indicating a cumulative effect concerning problems that hinder the sustainable development of innovative companies.

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Analysis of the influence of control variables in the SustPerf models confirmed the findings of scientists (Drempetic, Klein, & Zwergel, 2019; Dicuonzo et al., 2022; Aulia & Hambali, 2023; Anqi et al., 2023) on the positive role of increasing company size in achieving sustainability performance measures (ESG, E, and S), since large innovative companies have higher social responsibility and greater financial and organizational capacity to standardize sustainable practices and ensure their higher quality.

The study has a number of limitations that scientists should consider in the future when using and interpreting its results, as well as when formulating new research directions. First, the analysis period is limited to three years and can be extended to more accurately determine the impact of lagged and R&D investments on financial performance. Secondly, even though the most active innovative companies were included in the studied sample, to obtain more accurate results, they can also be further classified according to the level of their innovative activity and industry affiliation. Thirdly, other methodological tools than LSEG assessment tools can be used to analyze the sustainable performance of innovation companies. Fourthly, in addition to Western European companies with an active innovation policy, the sample under study can also be expanded by including innovative companies from Eastern Europe.

CONCLUSIONS

The article aims to analyze whether R&D investments affect financial (ROA, ROE, EBITm, and ROCE) and sustainable performance (ESG, E, S, and G) measures. Based on R&D investment data from 244 innovative Western European companies for 2021–2023, the impact of these investments on financial and sustainable performance was analyzed, yielding mixed results.

A positive short-term impact of R&D investment on ROA, ROE, and ROCE is found, but the lagged values (RD_{t-1} and RD_{t-2}) lose their significance. This indicates that the impact of R&D investment mainly manifests itself within one year, after which its impact on financial performance disappears. A negative impact of R&D intensity on all financial performance measures was also established, which can be explained by excessive R&D investments without corresponding efficiency or rapid obsolescence of innovations, a characteristic feature of companies from innovation-intensive industries.

An analysis of the impact of R&D investments on sustainable performance revealed a limited positive impact of R&D costs on ESG and G, with the effect lasting for 1-2 years. The identified negative impact of R&D intensity on ESG, E, and G, which increases over time, results from the lack of resources to implement high-quality sustainable practices and indicates a conflict between innovation and sustainability goals in innovative companies. It was also confirmed that companies with a high l_Size score demonstrate higher sustainability performance due to a larger resource base and standardized sustainable practices.

The study's scientific novelty lies in expanding theoretical concepts and obtaining empirical data regarding the impact of R&D investments on the financial performance and sustainable development practices of innovative companies. The study has a number of practical implications for innovation management that can help companies improve their financial performance and achieve their sustainability goals. First, since the financial effect of R&D investments quickly disappears, it is necessary to constantly develop short-term innovations, update innovation projects, and prevent innovations from becoming obsolete. Second, since excessive R&D intensity may worsen both financial performance and sustainable performance measures, it is necessary to regularly optimize R&D investments towards selecting higher-quality innovations in terms of the commercialization of innovative products. Third, to achieve long-term effects from R&D investments, it is necessary to combine R&D practices with strategic innovation management initiatives and sustainable practices of innovative companies, avoiding excessive concentration on one of these areas. Fourth, to benefit from economies of scale when it is not possible to increase the resources for effective innovation management and sustainable practices, innovative companies should join strategic innovation networks, alliances, or partnerships.

The following directions are proposed for future research in this field:

1. First, determining the optimal levels of R&D investments depending on the size and capabilities of innovative companies.
2. Second, conducting an in-depth analysis of the impact of lagged variables on financial performance and sustainable performance.
3. Third, investigating the reasons for the adverse effects of R&D investments on ESG indicators.
4. Fourth, analyzing the mechanisms of integrating innovation and ESG strategies to enhance sustainable performance.

5. Fifth, examining the optimal capital structure of innovative companies, taking into account industry-specific characteristics of their operations.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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Ужик Я., Легенчук С., Пойда-Носик Н., Остапчук Т., Цалко Т., Невмержицька С.

ЯКА ВАЖЛИВІСТЬ ІНВЕСТИЦІЙ У ДОСЛІДЖЕННЯ Й РОЗРОБКИ ДЛЯ ФІНАНСОВОЇ ТА СТАБІЛЬНОЇ ДІЯЛЬНОСТІ?

Метою дослідження є аналіз впливу інвестицій у дослідження й розробки (R&D) на фінансові та стійкі показники інноваційних компаній. Для регресійного аналізу впливу інвестицій у R&D на фінансові та стійкі показники було використано два типи моделей – моделі FinPerf і SustPerf. Ці моделі враховують і поточні, і відстрочені витрати на

R&D та інтенсивність R&D, що дозволяє побудувати 24 аналітичні моделі. На основі даних 244 західноєвропейських інноваційних компаній за 2021–2023 роки було виявлено, що витрати на R&D мають короткостроковий позитивний вплив на ROA, ROE та ROCE, але його ефект зникає через один рік. Водночас інтенсивність R&D демонструє негативний вплив на фінансові показники, що пояснюється надмірними витратами на інновації та їхньою низькою ефективністю. У контексті сталого розвитку інвестиції в R&D позитивно впливають на корпоративне управління та загальний показник ESG, але їх ефект також обмежений 1-2 роками. Водночас висока інтенсивність R&D погіршує стійкі показники, особливо в екологічній і державній царинах, що свідчить про конфлікт між інноваціями та цілями сталого розвитку. Великі інноваційні компанії демонструють кращі показники сталого розвитку завдяки своїм значним ресурсам і стандартизованим практикам. Результати підтверджують необхідність забезпечення балансу між обсягом інвестицій у дослідження й розробки та їхньою якістю, а також необхідність інтеграції інноваційних стратегій із практиками сталого розвитку.

Ключові слова: фінансові показники, стійкі показники, інвестиції в НДДКР, інтенсивність досліджень і розробок, оцінка ESG, сталий розвиток, інноваційні компанії

JEL Класифікація: G30, L25, O32, Q55

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