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BUSINESS ENTERPRISE EXPENDITURE ON RESEARCH AND DEVELOPMENT IN THE EUROPEAN UNION IN AN INTERNATIONAL CONTEXT*

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Abstract. This study examines the development of business enterprise expenditure on research and development (BERD) in the European Union between 2014 and 2024 and compares it with trends in selected global economies, namely the United States, Japan, China, and South Korea. The research employs descriptive time-series analysis and ordinary least squares (OLS) regression in a log-log specification to identify long-term trends, structural differences, and factors influencing business R&D investment. In addition, the study assesses environmental protection expenditure in selected European countries as a complementary indicator of sustainable competitiveness. The results show that although BERD in the European Union has increased steadily in absolute terms, the EU continues to lag behind all analysed economies when measured relative to economic performance. The regression analysis confirms a statistically significant positive relationship between economic size and BERD, while the estimated elasticity indicates that business R&D expenditure grows at a slower rate than the economy itself. Environmental protection expenditure also demonstrates an upward trend across the analysed countries, although the pace of growth differs considerably between individual states. The findings point to a persistent structural weakness within the European innovation system and highlight the need for more effective policy measures aimed at stimulating business investment in research and development. At the same time, the results emphasise the importance of supporting environmental investments as part of a broader strategy for strengthening the long-term competitiveness and sustainability of the European economy.

Keywords: business enterprise expenditure on research and development (BERD); European Union; innovation system; international comparison; OLS regression; competitiveness; research and development intensity; sustainability

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1. Introduction

Investment in research and development (R&D) is widely recognised as one of the key determinants of long-term economic growth and business competitiveness. In the context of a global economy characterised by rapid technological change and fluctuations in the prices of various materials, the ability of firms to systematically allocate resources to the development of new knowledge, processes, and products has become increasingly important (Cui et al., 2021; Imeida et al., 2023; Arabi, 2025). Empirical studies indicate that firms with higher levels of R&D investment achieve greater productivity, respond more flexibly to market changes, and perform more successfully in international competition (Boeing, Eberle & Howell, 2022; Bataineh et al., 2024; Saharti,

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2025). Consequently, Business Enterprise Expenditure on Research and Development (BERD) serves as an important indicator of technological advancement and the innovation potential of an economy.

Within the European Union, research and innovation have long held strategic importance. R&D policy has been shaped by initiatives such as the Lisbon Strategy, the Europe 2020 Strategy, and, more recently, the Cohesion Policy framework and the Horizon Europe programme, all of which emphasise the importance of strengthening investment in innovation as a means of achieving sustainable growth and technological sovereignty (Degirmenci & Yavuz, 2024; Pellens et al., 2024). Progress in this area is regularly monitored through indicators such as BERD, the share of R&D expenditure in gross domestic product (GDP), and the innovation capacities of Member States (Caglar et al., 2025). These frameworks reflect the European Union's efforts to enhance business competitiveness and promote a transition towards a knowledge-based economy.

In the international arena, the European Union faces growing competition from other major economies, particularly the United States, Japan, South Korea, and China. These countries consistently demonstrate high levels of business R&D expenditure and frequently achieve greater BERD intensity relative to GDP than the European Union average (Ersin et al., 2022; Arana-Barbier, 2023). A distinctive feature of the European Union is the considerable heterogeneity among its Member States. While countries such as Germany, Sweden, and Denmark rank among global innovation leaders, others exhibit lower investment levels and slower growth dynamics. This internal diversity affects the overall position of the Union within the global innovation landscape and slows the process of convergence towards the world's most advanced economies. Given the current challenges facing the European innovation system, a comprehensive analysis of business-sector investment in research and development within a broader international context is required.

The aim of this study is to evaluate the development of Business Enterprise Expenditure on Research and Development (BERD) in the European Union during the period 2014–2024, to assess the factors associated with the dynamics of these investments, and to compare the position of the European Union with selected major global economies, namely the United States, Japan, China, and South Korea. Based on these findings, conclusions are drawn regarding the development of the competitiveness of the European business sector.

To achieve this objective, the following research questions are formulated:

RQ1: How did business-sector expenditure on research and development (BERD) in the European Union evolve between 2014 and 2024 compared with the international average? Addressing the first research question enables the identification of both current and long-term trends in business R&D expenditure and places developments within the European Union in an international context.

RQ2: What relationship exists between economic size (GDP) and the level of business expenditure on research and development (BERD) in the selected economies (the European Union, the United States, Japan, China, and South Korea) during the period 2014–2024? Addressing this research question facilitates an analysis of the relationship between economic size, measured by gross domestic product (GDP), and the level of business expenditure on research and development (BERD).

RQ3: How did the position of the European Union in the global landscape of business expenditure on research and development (BERD) evolve between 2014 and 2024 compared with other major economies (e.g., the United States, Japan, South Korea, and China), and how did environmental protection expenditure develop across European countries during the same period as a complementary dimension of sustainable competitiveness? Addressing the third research question enables an assessment of the European Union's position within the global R&D environment and its level of competitiveness relative to other major economies. It also considers the development of environmental protection expenditure in European countries as part of the transition towards a sustainable and innovation-driven economy.

2. Theoretical background

Business Expenditure on Research and Development (BERD) is widely regarded as one of the key components of modern innovation systems and serves as an important indicator of the technological and innovative performance of economies (Biel, 2023; Vetsikas & Stamboulis, 2023). Sarpong et al. (2022) and Wyrwa (2022) interpret BERD as a fundamental instrument through which firms develop their innovation capacity, strengthen their ability to generate new knowledge, and transform such knowledge into innovative products, processes, and services (Kollmann et al., 2024; Fu, Li & Wu, 2024; Ferreira, Fernandes & Veiga, 2025). Baruk (2022) further argues that these activities contribute not only to enhancing business competitiveness but also to increasing productivity and supporting long-term economic development.

Leung and Sharma (2021) emphasise that the importance of business expenditure on research and development lies not only in its absolute volume but also in the stability and long-term continuity of such investments. According to the authors, the systematic implementation of R&D activities enables firms to accumulate knowledge more effectively and utilise it more efficiently over time, resulting in greater innovation performance and more favourable long-term economic outcomes. Maintaining such continuity, however, is often challenging for firms, as R&D investments are exposed to a range of economic and organisational constraints (Link & Sardar, 2023; Park & Lee, 2023; Nguyen & Nguyen, 2024). Based on an empirical analysis, Beladi et al. (2021) demonstrated that cash-flow uncertainty leads firms to adopt more cautious investment behaviour and reduce R&D expenditure, while financial constraints further amplify this negative effect. Similarly, Milani and Neumann (2022) conclude that even globally innovative firms experience reductions in R&D intensity due to financial limitations, with information asymmetry and firms' ability to mitigate it, for example through patent activity, playing a crucial role. Beyond financial constraints, Coad et al. (2021) highlight the existence of non-financial barriers, particularly the high uncertainty associated with research outcomes, the lengthy duration of research projects, and the limited availability of qualified human resources, all of which increase the complexity of corporate decision-making regarding the scale and continuity of R&D activities. Taken together, these findings suggest that firms' investment behaviour in research and development cannot be explained solely by financial constraints but rather results from the simultaneous influence of multiple interconnected factors (Kollmann et al., 2024). The strategic importance of business expenditure on research and development has recently been reinforced at the level of European Union policy by the Draghi report on European competitiveness (Draghi, 2024). The report identifies the persistent innovation gap between the European Union and its main global competitors, the United States and China, as one of the principal causes of Europe's slowing productivity and weakening competitive position. A central element of this diagnosis is the long-term underfunding of research and development by European firms; the report notes that in 2021 EU companies invested approximately EUR 270 billion less in research and innovation than their counterparts in the United States, and it argues that the Union's repeated failure to reach the long-standing target of devoting 3 % of GDP to R&D is a fundamental reason for this lag.

3. Research objective and methodology

The input data for the analysis of Business Expenditure on Research and Development (BERD) were obtained from the Eurostat database (Eurostat, 2025), which ensures the methodological comparability of indicators both within the European Union and across other global economies. The analysed period covers the years 2014–2024, with values reported in current prices and expressed in millions of euros. The selection of this time horizon enables the identification of long-term investment trends, including structural changes associated with exogenous shocks, particularly those observed in 2020. To assess the international position of the European Union, data from leading economies, namely the United States, China, Japan, and South Korea, were incorporated into the analysis. Based on these data, an international average was calculated and used as a benchmark for evaluating global competitiveness. A supplementary analysis of environmental protection expenditure was conducted using data from the OECD database (OECD, 2025). The dataset covers selected European countries for the period 2014–2022. To ensure comparability across countries, all values were converted into an index with the base year 2014 (= 100). An overview of all variables included in the analysis, together with their sources and units of measurement, is presented in Table 1.

Table 1. Overview of Variables Used in the Analysis

Variable	Description	Source	Unit
BERD	Business expenditure on research and development	Eurostat	EUR million
GDP	Gross domestic product	Eurostat	EUR million
BERD_intensity	BERD intensity as a share of GDP	Eurostat	% of GDP
BERD_avg	International average BERD	Author's calculation	EUR million
EPE_index	Environmental protection expenditure index	OECD	2014 = 100

Source: Authors' own elaboration

Descriptive Analysis

Descriptive time-series analysis is employed to identify long-term trends, structural breaks, and differences in the dynamics of BERD across the analysed economies. Through graphical representation of both the absolute values of BERD and its intensity relative to GDP, the relative position of the European Union within the global context is assessed, together with the extent of its convergence towards or divergence from the world's most technologically advanced economies.

All visualisations were produced using the Python programming language, which is widely utilised in scientific computing and data analysis due to its extensive ecosystem of specialised libraries. The Pandas library was employed for data loading, transformation, and manipulation, enabling efficient processing of tabular time-series data. Numerical computations and matrix operations were performed using the NumPy library. Graphical outputs were generated with Matplotlib, which provides extensive capabilities for producing publication-quality visualisations, including multi-line time-series charts that facilitate a clear comparison of developments across economies throughout the analysed period (Ono, Feire & Silva, 2021).

Regression Analysis

To examine the relationship between economic size, measured by gross domestic product (GDP), and the level of business expenditure on research and development (BERD), a simple linear regression model estimated by the Ordinary Least Squares (OLS) method is applied. Given the substantial variation in the magnitude of both variables and in order to linearise their relationship, both variables were transformed using natural logarithms, resulting in the following log–log model specification:

$$\log(\text{BERD}) = \beta_0 + \beta_1 \cdot \log(\text{GDP}) + \varepsilon$$

where:

- $\log(\text{BERD})$ represents the dependent variable, expressed as the natural logarithm of business expenditure on research and development;
- $\log(\text{GDP})$ denotes the independent variable, representing the natural logarithm of gross domestic product;
- β_0 is the intercept term;
- β_1 is the regression coefficient measuring the elasticity of BERD with respect to GDP; and
- ε represents the random error term.

Within the log–log specification, the coefficient β_1 has a direct elasticity interpretation, indicating the percentage change in BERD associated with a one-percent change in GDP, *ceteris paribus*.

4. Results and discussion

To address the research questions, an analysis of the development of business expenditure on research and development (BERD) in the European Union over the period 2014–2024 was first conducted. BERD represents a key indicator of innovation activity within the business sector and reflects the technological sophistication of an economy.

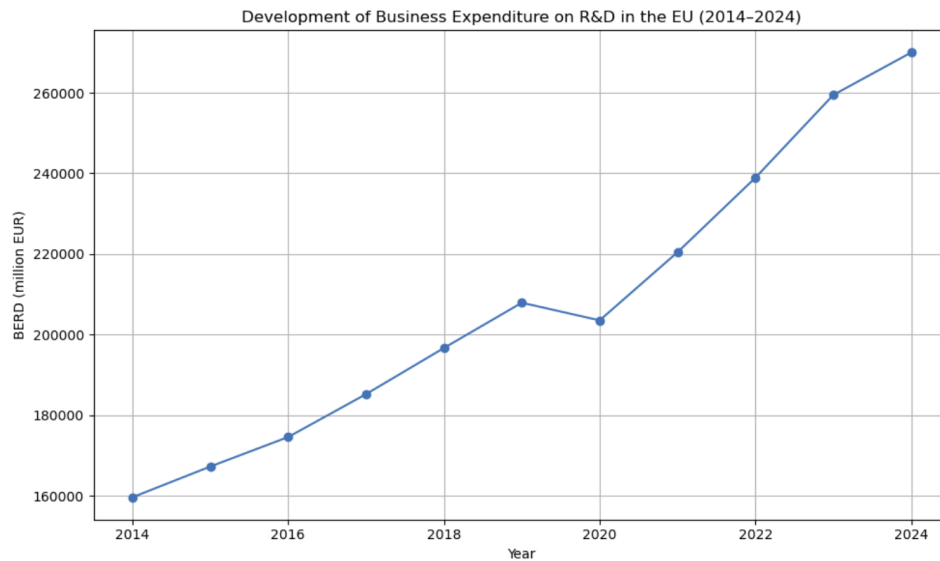


Figure 1. Development of BERD, 2014–2024

Source: Authors' own elaboration based on Eurostat data

Figure 1 illustrates a substantial increase in business expenditure on research and development within the European Union between 2014 and 2024. The only exception was a slight decline in 2020, attributable to the COVID-19 pandemic, after which growth resumed. Overall, the results indicate a long-term upward trend in investment in research and innovation across the European Union. This development suggests that European firms increasingly prioritise innovation and technological advancement. The growth in R&D expenditure may be associated with several factors, including public-sector support, increasing competition in global markets, and the need to keep pace with rapidly evolving technologies. The long-term increase in BERD represents an important indicator of future economic prosperity and competitiveness within the European Union, as innovation frequently contributes to the development of new products, services, and market opportunities.

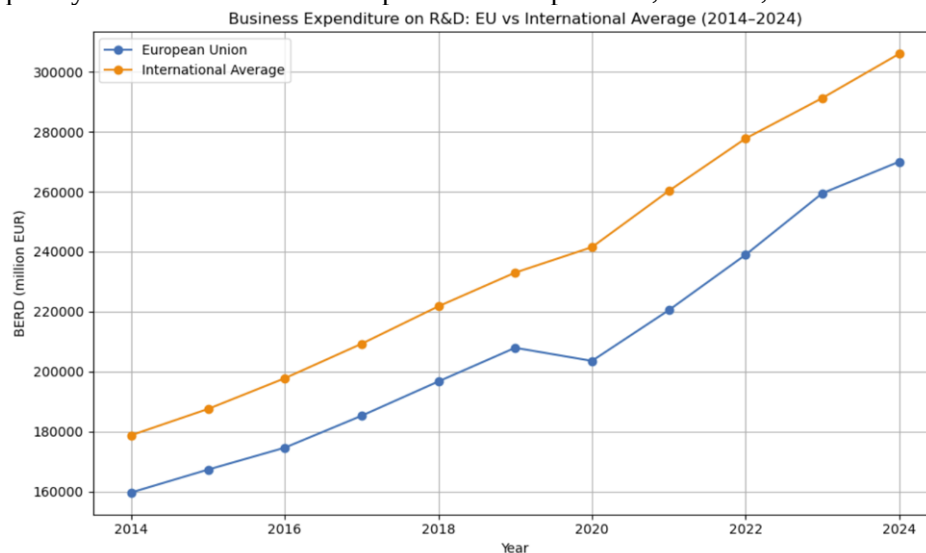


Figure 2. Comparison of the European Union and the Average of Selected Economies

Source: Authors' own elaboration based on Eurostat data

Figure 2 presents the development of BERD in the European Union compared with the average of selected global economies (the United States, Japan, China, and South Korea) between 2014 and 2024. Both groups exhibit a continuous increase in business-sector investment in research and development. However, the international average remained consistently above the European Union throughout the entire period. A moderate decline was observed in 2020 as a consequence of the COVID-19 pandemic, followed by renewed growth, particularly among the selected global economies. The temporary downturn was more pronounced in the

European Union than in the comparison group. These findings point to persistent differences in the intensity of business investment in research and development between the European Union and technologically advanced economies, which may have important implications for the long-term competitiveness of the European innovation system.

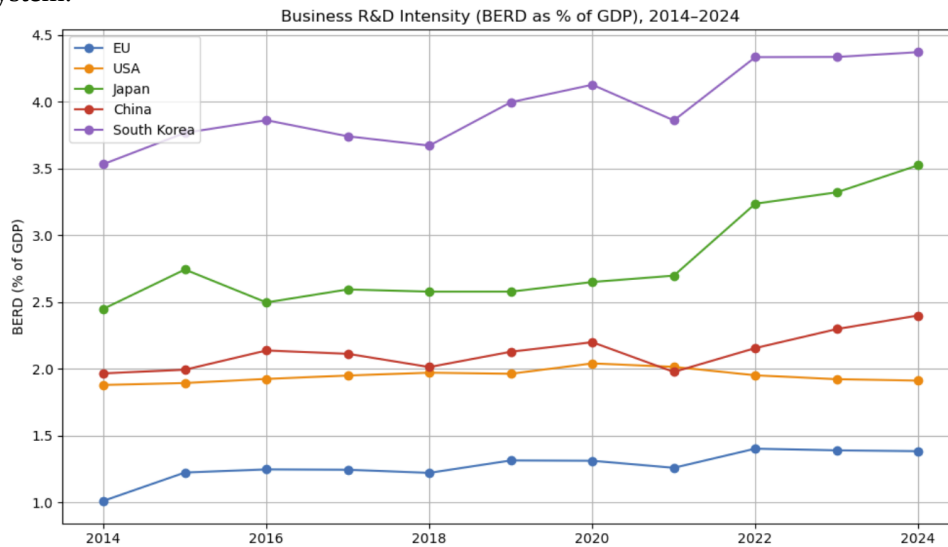


Figure 3. BERD Intensity as a Percentage of GDP, 2014–2024

Source: Authors' own elaboration based on Eurostat data

Figure 3 illustrates BERD intensity measured as a share of GDP, enabling comparisons across economies of different sizes. South Korea occupies a dominant position, with BERD intensity ranging from approximately 3.5% to 4.3% of GDP and exhibiting a generally upward trend. Japan records values between 2.5% and 3.5% of GDP and demonstrates a notable increase towards the end of the analysed period. China has strengthened its position considerably, with BERD intensity rising from approximately 2.0% to 2.4% of GDP, reflecting sustained governmental support for innovation. The United States displays relatively stable values around 2.0% of GDP. In contrast, the European Union remains behind these economies, with BERD intensity fluctuating between 1.0% and 1.4% of GDP and showing only gradual growth. These findings indicate that the challenge faced by the European Union is not merely the absolute level of business R&D expenditure but, more importantly, its relatively low intensity in relation to the size of the economy. This represents a structural weakness of the European innovation system with potentially significant consequences for long-term competitiveness.

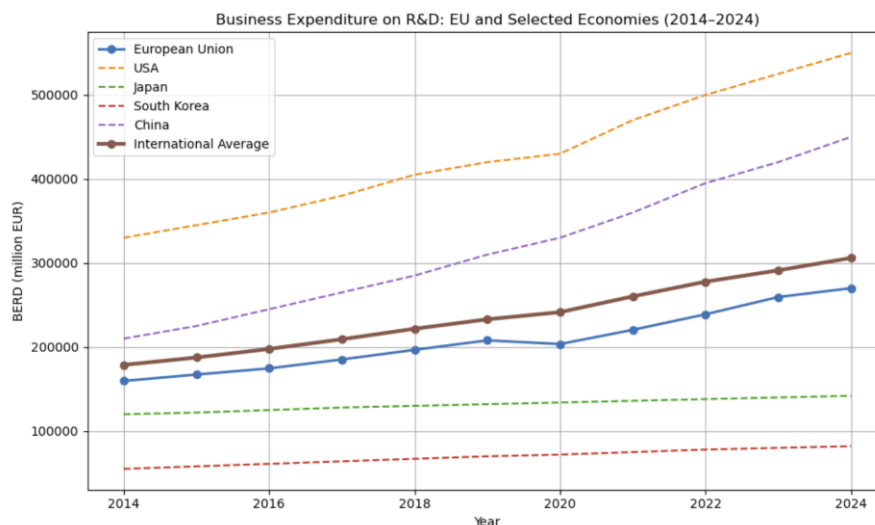


Figure 4. Business Expenditure on Research and Development in the European Union and Selected Economies – Detailed Comparison (2014–2024)

Source: Authors' own elaboration based on Eurostat data

Figure 4 extends the comparison presented in Figure 2 by supplementing the international average with the individual trajectories of the analysed economies, thereby providing a more detailed perspective on the structure of the global R&D environment. The results reveal that the international average shown in the previous figure is driven primarily by the exceptional performance of the United States and the rapid growth of China. While the United States maintained the highest absolute levels of BERD throughout the analysed period, China exhibited the strongest growth dynamics and progressively narrowed the gap with the United States. Japan and South Korea occupied relatively stable but considerably lower positions. The European Union remained between Japan and South Korea; however, its growth trajectory was noticeably slower than those of both China and the United States. Consequently, the findings provide further evidence of the investment gap identified in Figure 2 and demonstrate that this gap is largely shaped by the performance of two dominant economies against which the European Union continues to lag in absolute terms.

Table 2. Results of the OLS Regression Model

OLS Regression Results			
Dep. Variable	log_BERD	R-squared	0.900
Model	OLS	Adj. R-squared	0.899
Method	Least Squares	F-statistic	479.3
Date	Mon, 16 Mar 2026	Prob (F-statistic)	3.24e-28
Time	10:39:18	Log-Likelihood	8.1752
No. Observations	55	AIC	-12.35
Df Residuals	53	BIC	-8.336
Df Model	1		
Covariance Type	nonrobust		

Source: Authors' own elaboration based on Eurostat data

Table 2 presents the results of the regression analysis estimated using a log–log specification, the purpose of which was to examine the relationship between economic size and the level of business expenditure on research and development. The estimated model demonstrated a high explanatory power, with a coefficient of determination of $R^2 = 0.900$, indicating that 90% of the variation in the dependent variable, $\log(\text{BERD})$, is explained by variation in $\log(\text{GDP})$. The overall statistical significance of the model is confirmed by an F-statistic of 479.3 ($p < 0.001$). The model was estimated using 55 observations, with one degree of freedom for the model and 53 residual degrees of freedom. The log-likelihood value equals 8.175, while the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) attain values of -12.35 and -8.336 , respectively, indicating a good fit of the model to the data. The adjusted coefficient of determination $R^2 = 0.899$ further confirms that the high explanatory power of the model is not the result of over-parameterisation. More detailed results of the estimated parameters and diagnostic tests are presented in Table 3.

Table 3. Estimated Parameters and Diagnostic Tests of the OLS Model

	coef	std err	t	P> t	[0.025	0.975]
const	6.3680	0.896	7.110	0.000	4.572	8.164
log_GDP	0.6585	0.030	21.893	0.000	0.598	0.719
Diagnostic Tests						
Omnibus	6.923		Durbin-Watson		0.249	
Prob(Omnibus)	0.031		Jarque-Bera (JB)		6.644	
Skew	-0.850		Prob(JB)		0.0361	
Kurtosis	3.077		Cond. No.		932.	

Source: Authors' own elaboration based on Eurostat data

The estimated regression coefficient for the variable $\log(\text{GDP})$ is $\beta_1 = 0,6585$ ((std. err. = 0,030; $t = 21,893$; $p < 0,001$), with a 95% confidence interval ranging from 0.598 to 0.719. The intercept term is estimated at $\beta_0 = 6,368$ (std. err. = 0,896; $t = 7,110$; $p < 0,001$). Within the log–log specification, the estimated coefficient can be interpreted as an elasticity measure. Specifically, a 1% increase in GDP is associated with an approximately 0.66% increase in BERD, ceteris paribus (Figure 5). The fact that the estimated elasticity is lower than one suggests that business expenditure on research and development grows at a slower rate than the economy itself.

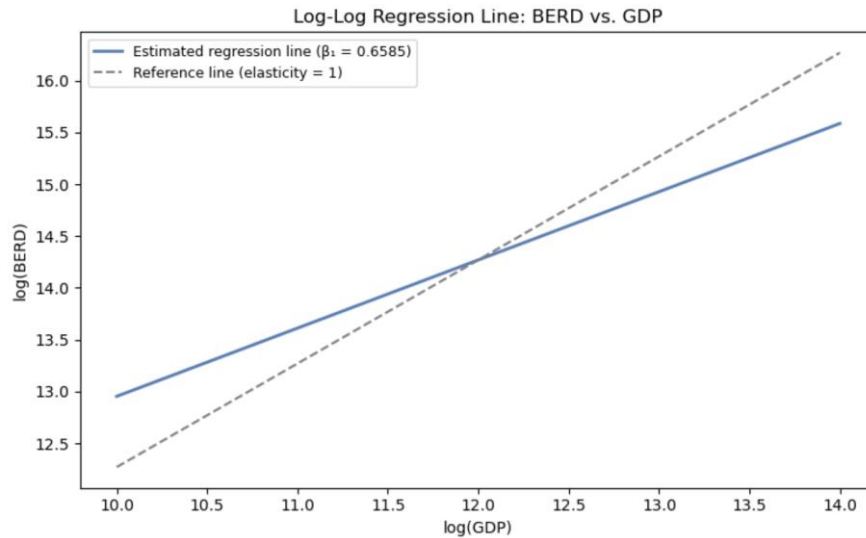


Figure 5. Interpretation of Elasticity

Source: Authors' own elaboration based on Eurostat data

The diagnostic tests indicate several limitations that should be considered when interpreting the results. The low value of the Durbin–Watson statistic (0.249) suggests the presence of positive autocorrelation in the residuals, which is expected given the time-series structure of the data. Furthermore, the Jarque–Bera test ($p = 0.036$) indicates a moderate deviation of the residuals from a normal distribution. Despite these limitations, the overall explanatory power of the model remains high.

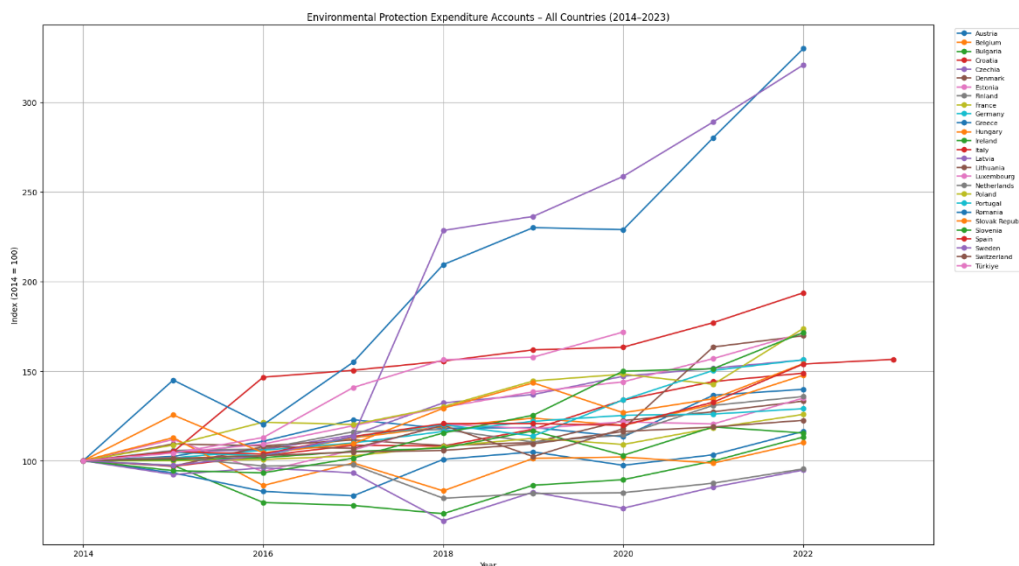


Figure 6. Growth Dynamics of Environmental Protection Expenditure in Selected European Countries (Index, 2014 = 100)

Source: Authors' own elaboration based on OECD data

Using OECD data on national environmental protection expenditure, the growth dynamics of environmental spending in selected European countries were analysed for the period 2014–2022 (Figure 6). To ensure comparability across countries, all values were converted into an index with the base year 2014 set equal to 100. The resulting index therefore reflects the relative change in environmental protection expenditure compared with the baseline year. The findings suggested that environmental expenditure generally increased across most of the analysed countries, indicating a gradual strengthening of activities related to environmental protection and sustainable development. However, the growth of environmental expenditure varied considerably among countries.

The most pronounced growth dynamics were observed in Sweden and Romania. In Sweden, the indicator increased sharply, particularly after 2017, with the index exceeding 320 in 2022. This represented more than a threefold increase in environmental expenditure compared with 2014. A similar trend was identified in Romania, where the index reached approximately 330 in 2022. Such substantial growth may have been associated with increased support for environmental projects, infrastructure modernisation, and the utilisation of European Union financial instruments aimed at facilitating the green transition.

Significant growth was also evident in Italy, Poland, and the Czech Republic. In the Czech Republic, the index exhibited steady growth throughout the analysed period, increasing from approximately 102 points in 2014 to more than 160 points in 2022. This development suggested a gradual strengthening of investments in environmental protection activities, particularly in waste management, wastewater treatment, energy efficiency measures, and the adoption of environmentally friendly technologies.

In contrast, Germany, France, Belgium, and Austria displayed more moderate growth patterns. Index values in these countries generally ranged between 130 and 150 points. Although the growth dynamics were less pronounced than in many Central and Eastern European countries, these findings should not be interpreted as evidence of low levels of environmental investment. The more moderate pace of growth may reflect the fact that these countries already possessed relatively high levels of environmental expenditure at the beginning of the analysed period, resulting in more gradual increases over time.

Among some smaller economies, such as Latvia, Bulgaria, and Greece, more substantial year-to-year fluctuations in index values were observed. This volatility may have been influenced by lower overall investment volumes, greater sensitivity to individual large-scale projects, or variations in the utilisation of public funding programmes.

The results of the analysis provide an empirical basis for addressing the three research questions and allow the findings to be interpreted within the broader context of the existing literature.

RQ1: How did business-sector expenditure on research and development (BERD) in the European Union evolve between 2014 and 2024 compared with the international average?

The first research question focused on the development of business expenditure on research and development in the European Union between 2014 and 2024 in comparison with the international average. The descriptive analysis revealed that BERD in the EU followed an upward trend throughout the analysed period, interrupted only by a temporary decline in 2020 as a consequence of the COVID-19 pandemic. This finding is consistent with Pellens et al. (2024), who argue that economic crises typically lead to a temporary reduction in R&D investment, while the subsequent recovery depends largely on the stability of the macroeconomic environment. Although the absolute value of BERD in the EU increased steadily over time, the international average exceeded EU levels throughout the entire period, and the gap between them gradually widened. This conclusion is in line with the findings of Dachs et al. (2024), who emphasise that the European Union continues to lag behind the leading global economies in terms of business R&D expenditure despite sustained growth in investment.

RQ2: What relationship exists between economic size (GDP) and the level of business expenditure on research and development (BERD) in the selected economies (the European Union, the United States, Japan, China, and South Korea) during the period 2014–2024?

The second research question examined the relationship between economic size, measured by GDP, and the volume of business expenditure on research and development. The OLS regression analysis using a log–log specification confirmed a statistically significant positive relationship between the two variables ($\beta_1 = 0.6585$; $p < 0.001$; $R^2 = 0.900$). The estimated elasticity, which is below one, indicates that business expenditure on research and development grows at a slower rate than the economy as a whole. This finding is consistent with the conclusions of Chmielewski et al. (2025), who argue that economic size alone is insufficient to achieve high levels of BERD. The results also correspond with the findings of Santos et al. (2024), who emphasise that firms' decisions regarding R&D investment are influenced not only by economic potential but also by the availability

of financial resources, institutional conditions, and the degree of uncertainty associated with the returns on innovation projects.

RQ3: How did the position of the European Union in the global landscape of business expenditure on research and development (BERD) evolve between 2014 and 2024 compared with other major economies (e.g., the United States, Japan, South Korea, and China), and how did environmental protection expenditure develop across European countries during this period as a complementary dimension of sustainable competitiveness?

The third research question addressed the evolution of the European Union's position within the global landscape of business expenditure on research and development. The analysis of BERD intensity as a percentage of GDP indicates that the EU lags considerably behind the analysed economies, including South Korea, Japan, China, and the United States. Furthermore, the observed growth rate appears insufficient to eliminate this structural gap. This conclusion is consistent with the findings of Moncada-Paternò-Castello and Grassano (2022), who argue that the lower BERD intensity observed in the EU is associated with a lower concentration of technologically advanced firms and weaker integration into international knowledge networks. The dynamic growth of business R&D expenditure in China, also highlighted by Fu et al. (2024), represents a significant competitive challenge and further influences the EU's position within the global innovation landscape. By contrast, the stable yet dominant position of the United States supports the conclusions of Belderbos et al. (2023) regarding the enduring technological leadership of the American business sector.

From the perspective of sustainable competitiveness, the supplementary analysis of environmental protection expenditure growth (Figure 6) revealed that European countries generally increased their environmental investments during the period 2014–2022, although with substantial variation across countries. While Sweden and Romania recorded more than a threefold increase in the expenditure index, and the Czech Republic, Italy, and Poland demonstrated steady growth, several Western European countries experienced more moderate increases from already high initial levels. This pattern reflects the growing integration of innovation and environmental policies within the framework of the Cohesion Policy and the Horizon Europe programme, as highlighted by Degirmenci and Yavuz (2024) and Caglar et al. (2025). The findings suggest that strengthening business R&D expenditure and promoting investment in the green transition constitute complementary pillars of the long-term competitiveness of the European economy.

Overall, the results are consistent with the broader literature on the determinants of business investment in research and development. The relatively low BERD intensity observed in the European Union is partly explained by structural characteristics of the European business sector, particularly the lower representation of technologically advanced industries and the high proportion of small and medium-sized enterprises, which face specific barriers to engaging in research-oriented activities, as noted by Czarnitzki and Giebels (2024) and Rajamani et al. (2022). Moreover, the persistent heterogeneity among EU Member States, emphasised by Chmielewski et al. (2025), further weakens the overall position of the European Union, as the strong performance of Northern and Western European countries is offset by substantially lower investment levels in many Southern and Central European economies. Enhancing the innovation performance of the EU therefore requires not only higher levels of business expenditure on research and development but also improvements in the institutional environment, stronger collaboration between businesses, universities, and the public sector, and more effective utilisation of public support instruments for research and innovation, as suggested by Rossoni et al. (2024), Dong et al. (2025) and Stoeber and Kanbach (2025).

Conclusions

The aim of this study was to analyse the development of Business Expenditure on Research and Development (BERD) in the European Union between 2014 and 2024, to assess the factors influencing its dynamics, and to compare the position of the EU with selected major global economies, namely the United States, Japan, China, and South Korea. To achieve this objective, descriptive time-series analysis and Ordinary Least Squares (OLS) regression in a log–log specification were applied to data obtained from the Eurostat database. The analysis was further complemented by an assessment of environmental protection expenditure in selected European countries based on OECD data, considered as a complementary dimension of sustainable competitiveness.

The results of the descriptive analysis demonstrated that business expenditure on research and development in the European Union followed a long-term upward trend, interrupted only by a temporary decline in 2020 due to the COVID-19 pandemic. Although the absolute level of BERD in the EU increased over time, the international average derived from the selected global economies remained consistently higher throughout the analysed period, and the investment gap gradually widened. The analysis of BERD intensity as a percentage of GDP revealed that the challenge faced by the EU is not limited to the absolute volume of investment but is primarily associated with its relatively low intensity, which remained at approximately 1.0–1.4% of GDP. This contrasts sharply with South Korea, where BERD exceeded 4% of GDP, and Japan, where it approached 3.5% of GDP. This structural deficit indicates that the European Union has not fully utilised its economic potential to support business-sector innovation activities. The supplementary analysis of environmental protection expenditure further showed that European countries generally increased their environmental investments between 2014 and 2022, albeit with substantial heterogeneity. While the expenditure index more than tripled in Sweden and Romania, growth was more moderate in Western European countries that already exhibited relatively high initial expenditure levels.

The regression analysis confirmed a statistically significant positive relationship between economic size, measured by GDP, and the level of business expenditure on research and development. However, the estimated elasticity, which was lower than one, indicates that BERD grows at a slower rate than the economy itself. This finding suggests that while economic size represents an important predictor of BERD, it is not a sufficient condition for achieving high levels of business R&D expenditure. Institutional quality, industrial structure, and the availability of financing for innovation activities also play a crucial role. A particularly noteworthy finding is the exceptionally dynamic growth of business R&D expenditure in China, which is progressively approaching the level of the United States and represents an increasingly significant competitive challenge for the European Union.

The novelty of this study lies in three aspects. First, it places EU business expenditure on research and development in an international comparative framework for 2014–2024 and shows that the EU's principal weakness is not the absolute volume of R&D but its persistently low intensity relative to South Korea, Japan, and, increasingly, China. Second, by integrating environmental protection expenditure into the analysis, it provides empirical support for treating innovation investment and the green transition as complementary rather than competing pillars of sustainable competitiveness. Third, the log–log specification shows that the elasticity of business R&D with respect to economic size is significantly below unity, confirming that economic growth alone does not translate into a proportional increase in business R&D. Together, these findings offer up-to-date evidence directly relevant to the concerns raised in the Draghi report.

The findings indicate that the European Union faces a structural deficit in business expenditure on research and development, both in absolute and relative terms. Addressing this gap requires systemic measures at multiple levels. Particular emphasis should be placed on strengthening the institutional environment that supports innovation, enhancing cooperation between businesses, universities, and the public sector, improving the effectiveness of public support instruments for research and development, and reducing the structural barriers faced by small and medium-sized enterprises. At the same time, the results suggest that strengthening business R&D activities and investing in the green transition constitute complementary pillars of long-term competitiveness. Without such measures, the investment gap between the European Union and global innovation leaders is likely to widen further, potentially undermining the long-term competitiveness and technological autonomy of the European economy.

Several limitations should be considered when interpreting the results. The regression analysis is based on aggregated data at the economy level and therefore does not capture heterogeneity among individual EU Member States or differences in the sectoral structure of R&D investment. Similarly, the descriptive comparison of environmental expenditure should be regarded as indicative, as it relies on indexed values covering the shorter period of 2014–2022. Future research should focus on panel-data analysis at the Member State level in order to identify the specific factors underlying investment gaps within the European Union. Further studies should also explore the relationship between business R&D expenditure and investments in sustainability and environmental protection in greater depth.

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