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SECURITY IN THE CONTEXT OF SUSTAINABILITY: THE IMPLICATIONS ON DEFENCE EXPENDITURES

BĂTUȘARU Cristina Maria
"Nicolae Bălcescu" Land Forces Academy of Sibiu, Romania

SBÂRCEA Ioana Raluca
Lucian Blaga University of Sibiu, Romania

Abstract:

This scientific article aims to assess the link between defence expenditures and sustainable development in Romania. As the world faces increasingly complex security challenges and environmental concerns, it becomes crucial to examine the interplay between defence investments and sustainable development goals. The study focuses specifically on Romania, a country that has been undergoing significant economic and political transformations since joining the European Union. The analysis employs a comprehensive framework that integrates economic, social, and environmental indicators to evaluate the sustainability implications of defence expenditures. Using data from various sources, including national statistics and international databases, this study examines the trends in defence spending in Romania over a specified period. The research investigates the potential trade-offs between defence investments and sustainable development outcomes by considering key dimensions such as economic growth, social well-being, and environmental impact. By examining the case of Romania, valuable insights can be gained regarding the challenges and opportunities in balancing defence expenditures with sustainable development priorities. The study not only provides a comprehensive analysis of the current situation but also identifies potential pathways for enhancing the sustainability of Romania's defence sector. This study contributes to the broader discourse on sustainable security fostering a more resilient and sustainable future.

Key words: *sustainability, economic development, defence expenditure, resilience.*

1. Introduction

In an era characterised by complex global challenges, the connection between sustainable development objectives and defence expenditures has emerged as a topic of increasing importance. The allocation of financial resources towards defence is a critical aspect of national security, ensuring the protection of a nation's interests, its citizens, and its territorial integrity. However, as the world confronts pressing issues such as climate change, resource depletion, and social inequality (Ashford, N. A., et. al.; 2020), it becomes imperative to evaluate the implications of defence spending on sustainable development goals.

Sustainable development, as defined by the United Nations, encompasses the harmonious integration of economic growth, social inclusion, and environmental protection. It represents a holistic approach to development that seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. In this context, the assessment of defence expenditures becomes crucial in understanding the potential trade-offs between security priorities and sustainability objectives.

The subject of assessing defence expenditures in the context of sustainable development holds significant importance for several reasons. Firstly, defence budgets often represent a substantial portion of a country's overall expenditures, competing with other sectors for limited financial resources. This makes it essential to evaluate the economic implications of defence investments and determine their potential impact on long-term sustainable economic growth.

Secondly, sustainable development is inherently linked to social progress and inclusivity. Defence expenditures should be examined in terms of their potential effects on social welfare, including access to healthcare, education, and basic social services. By understanding the social implications of defence spending, policymakers can strive for a balanced approach that ensures security while simultaneously addressing social inequalities and promoting well-being.

Thirdly, the environmental dimension of sustainable development necessitates a careful examination of defence expenditures. Military operations, infrastructure, and the production of weapons can have significant ecological footprints, contributing to greenhouse gas emissions, land degradation, and pollution. Therefore, it is crucial to assess the environmental impacts of defence spending and explore opportunities to align military practices with sustainable environmental practices, such as adopting renewable energy sources and promoting resource efficiency.

Furthermore, the subject of assessing defence expenditures in the context of sustainable development holds global relevance. Many countries face the challenge of balancing security needs with sustainable development objectives, and lessons learned from examining different national contexts can inform best practices and policy recommendations at the international level. Understanding the complexities and potential synergies between defence and sustainability can contribute to a more integrated and comprehensive approach to security, one that recognizes the interconnections of economic, social, and environmental systems.

2. Literature Review

In the specialised literature, there are numerous researches and scientific papers that deal with the issue of defence expenditures in the context of economic development, but reaching the dimensions of sustainable development represents a topical and still insufficiently exploited research niche. Numerous works have addressed public defence expenditures from the perspective of the advantages of security assurance and their implications in economic development (Ahuja, D., & Pandit, D.; 2020), referring to the component of investments in the defence sector. The link between defence expenditures and

economic development is a complex and multifaceted connection that has been subject to extensive analysis and debate (Ram, R.; 2019). While defence expenditures can have both positive and negative impacts on economic development, the overall linkages are often nuanced and contingent upon various factors.

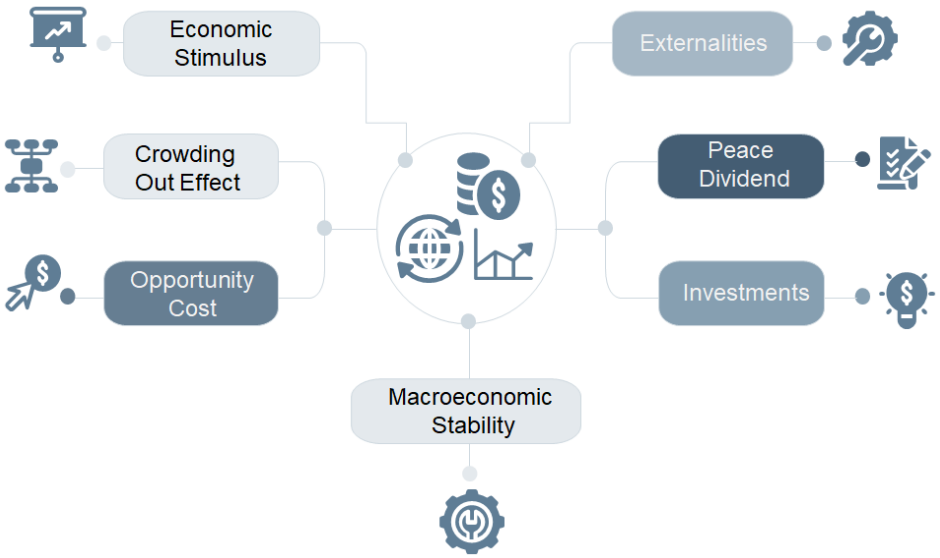


Figure 1. Main impacts of defence expenditure on economic development
Source: Authors' conceptualisation

Defence expenditures can stimulate economic activity through government spending on defence contracts, research and development, and infrastructure development (Braşoveanu, L. O.; 2010; Feridun, M.; Sawhney, B.; Shahbaz, M.; 2011). These investments create demand (Blum, J.; 2019), generate employment opportunities, and foster technological advancements, thereby contributing to economic growth and development (Mylonidis, N.; 2008). The defence sector can act as a catalyst for innovation and technological progress (Petrović, P., Arsić, M., & Nojković, A.; 2021), spurring advancements that can have positive spillover effects on other industries.

On the other hand, high levels of defence spending can lead to a phenomenon known as the crowding out effect. When a significant portion of a country's resources is allocated to defence, it may divert funds away from other sectors, such as education, healthcare (ChediI, M.M.A.; 2022), infrastructure, and social welfare (Mylonidis, N.; 2008). This can potentially hinder investment in areas that are crucial for long-term economic development (Waszkiewicz, G., 2020) and human capital formation (Ćutić, D.; 2020).

Defence expenditures also involve an opportunity cost, representing the alternative uses of resources foregone due to defence investments (Shaaba Saba, C., & Ngepah, N.; 2019). Resources allocated to the defence sector may be diverted away from productive sectors of the economy (Duella, A.; 2014) such as manufacturing, services, or research and development in non-defense areas. The opportunity cost of defence expenditures lies in the potential foregone benefits that could have been derived from alternative investments

that promotes economic diversification and competitiveness (Chairil, T.; Sinaga, D.; Febrianti, A.; 2013).

Defence spending can influence macroeconomic stability. High levels of defence expenditures can lead to budgetary imbalances and fiscal pressures, resulting in increased public debt and potential macroeconomic instability (Versal, N.,et. al.; 2023). Moreover, defence spending can impact inflation rates, exchange rates, and interest rates, affecting overall economic stability (Ivashyna, O., et. al.; 2023).

Defence expenditures can generate positive externalities for the economy. Investments in defence-related research and development can lead to technological advances that have spillover effects on civilian industries (Hartley, K., & Belin, J.; 2019). Defence-related industries often drive innovation (Ologbenla, P.; 2020), contributing to advancements in areas such as aerospace, telecommunications, and information technology, which can subsequently benefit the broader economy (Ortiz, C., et. al.; 2021; Ceyhan, T., et.al.; 2021).

In some cases, reduced defence spending due to improved international relations or a shift in security priorities can create a "peace dividend" (Sustikarini, A.; 2019). The reallocation of resources from defence to other sectors can stimulate economic development (Wong, C.; 2022)., allowing for investments in education, healthcare, infrastructure, and social welfare programs (Zhang, Y.; Liu, X.; Xu, J.; Wang, R.; 2016). This reallocation can contribute to long-term sustainable economic growth and development.

It is important to note that the link between defence expenditures and economic development is context-specific and varies across countries and time periods. Factors such as the level of security threats, geopolitical dynamics, government policies (Becker, W.S.; 2011), and institutional frameworks can significantly influence the dependence. Therefore, a comprehensive assessment of defence expenditures in relation to economic development requires a careful analysis of these factors to understand the specific dynamics at play in a given context.

Another direction of approach aimed at ensuring social welfare through the financing of security objectives and even aspects related to the military component and unemployment (Turner A.J.W.; ,2004). When considering the financing of security objectives, there were several ideas that promoted social welfare and ensured a balanced approach (Russett, B.; 1982; Marie Baylouny, A.; 2008).

Allocate a portion of defence expenditures towards investing in human capital development. This can include funding for education and vocational training programs that enhance the skills and employability of individuals. By prioritising education and skill-building initiatives, the defence sector can contribute to social welfare by creating opportunities for employment and economic mobility (Juliana, G. E. S., & Prakoso, L. Y.; 2022).

Allocate resources towards providing comprehensive support and welfare services for veterans. This can include healthcare programs, rehabilitation services, vocational training, and mental health support. Ensuring the well-being and social integration of veterans is crucial for their successful transition to civilian life (Qiong, L.; Junhua, H.; 2015) and can contribute to overall social welfare.

Direct a portion of defence expenditures towards the development of social infrastructure, such as healthcare facilities, schools, affordable housing, and community centres. This can address social welfare gaps in underserved communities (Sharif, A.; Afshan, S.; 2017) and contribute to overall social development. Investing in social infrastructure not only improves the quality of life for individuals but also creates jobs and stimulates local economies (Ang, J.B.; 2010).

Establish social safety net programs that provide assistance to vulnerable populations affected by defence-related activities, such as military base closures or displacement due to conflict or security measures (Nikolov, O.; 2018). These programs can include financial support, retraining opportunities, and access to social services (Sibbald, J.; 2016) to help affected individuals and communities navigate the challenges and maintain their well-being.

Allocate resources towards community development initiatives in regions where defence-related activities are concentrated. These initiatives can focus on improving local infrastructure, promoting entrepreneurship, supporting small businesses, and enhancing social cohesion. By investing in community development, the defence sector can contribute to long-term social welfare (Wolde-Rufael, Y.; 2014) and economic resilience.

Ensure that defence expenditures prioritise gender equality and diversity considerations. This can involve allocating resources for programs that promote gender mainstreaming, address gender-based violence, and increase the participation of women and marginalised groups in the defence sector (Graham, J.C.; Mueller, D., 2020). By actively promoting inclusivity and equality, the financing of security objectives can contribute to social welfare and create a more equitable society.

Foster collaboration between the defence sector and social welfare organisations, non-governmental organisations (NGOs), and civil society groups. By leveraging partnerships and expertise (Bouckaert, G., Peters, B. G., & Verhoest, K.; 2016), defence expenditures can be channelled effectively towards social welfare programs (Michael, C.; Stelios, R.; 2018). These collaborations can enhance the delivery of social services, leverage resources, and ensure a comprehensive approach to addressing social needs.

By incorporating these ideas into the financing of security objectives, it is possible to promote social welfare and ensure that defence expenditures contribute to the broader well-being of society. Balancing security priorities with social development objectives can foster a more inclusive and equitable society, where the benefits of defence investments are shared by all (Gül, E.; Torusdag, M.; 2019). Considering the equipment, technique and technology used in the defence sector, there were also works that dealt with the implications of the energy consumption that these capabilities entail.

Implement energy efficiency measures within the defence sector to minimise energy consumption and reduce environmental impact (Samaras, C., Nuttall, W. J., & Bazilian, M.; 2019). This can include adopting energy-efficient technologies, optimising transportation logistics, and improving energy management practices in military installations and operations (Forces, C.A.; 2017). By reducing energy consumption, defence expenditures can contribute to environmental sustainability (Wang, K. H., Su, C. W., Lobonţ, O. R., & Umar, M.; 2021) and support global efforts to mitigate climate change.

Allocating resources towards the adoption of renewable energy sources within the defence sector is really important. Investing in solar, wind, and other renewable energy technologies can reduce reliance on fossil fuels, decrease greenhouse gas emissions, and enhance energy security. By promoting the use of renewable energy, defence expenditures can lead the way in transitioning to a low-carbon economy and contribute to sustainable energy practices (Idris, A. M., Sasongko, N. A., & Kuntjoro, Y. D.; 2022).

By assessing and mitigating the environmental consequences of defence expenditures, measures can be implemented to minimise pollution, habitat destruction (Gokmenoglu, K. K., Taspinar, N., & Rahman, M. M.; 2021) and other adverse effects on ecosystems (Ahmed, Z., Zafar, M. W., & Mansoor, S.; 2020). This ensures that defence investments are made in an environmentally responsible manner. Allocate resources towards conservation and restoration projects in areas affected by defence-related activities, can involve reforestation efforts, habitat restoration, and biodiversity conservation measures (Eregha, P. B., et.al.; 2022). By investing in environmental conservation, defence expenditures can mitigate the ecological footprint and contribute to the preservation of natural resources and ecosystems. By promoting technological innovation, defence expenditures can drive advancements that not only enhance military capabilities but also contribute to environmental sustainability.

By incorporating these ideas into defence expenditures, it is possible to mitigate the consumption of energy and address environmental issues associated with military activities. This ensures that defence investments align with sustainable development goals and contribute to a greener and more environmentally conscious future.

Achieving the objectives regarding sustainable development can be a challenge when there is also the need to fulfil the obligations assumed through the treaties and conventions signed with international partners regarding ensuring national and regional security. But as long as the achievement of security objectives involves material, human and natural resources, the dimensions of sustainable development become imperative, so the question arises as to how defence expenditures can be transformed into sustainable ones. A relatively new research (Dudzeviciute, G.; 2021), particularly anchored in the present reality regarding the necessity and importance of defence spending in a context where economic development seeks to reach the dimensions of sustainability, presents the connection between defence spending and the sustainable development of the Baltic states. As proposed by the article's authors, the outcomes of their study could serve to uphold the security of the relevant nation as well as facilitate the realization of the Sustainable Development Goals. These objectives stood as key motivations for our research, which centered on the case of Romania.

3. Security sustainability: linking defence expenditures with sustainable development goals

Given the prevailing macroeconomic conditions, European states find themselves facing a dilemma. While they aim to boost spending on national defense, limited financial resources frequently compel them to scale back funding in certain civilian sectors or resort to borrowing

from international markets. Consequently, for smaller states, it becomes imperative for the security and defense sector to adopt an integrated approach that carefully considers a wide array of economic, social, and environmental factors.

3.1. Research Questions and Methodology

To validate the hypothesis on the significance of defense spending in fostering sustainable economic development at the national level, two methods, namely Automatic Linear Regression (ALM) and Forward Stepwise Regression (FSR), were employed. These methods helped identify the key factors impacting defense expenditure, which in turn affects sustainable economic growth. The analysis was performed using the SPSS statistical processing software, which is commonly used for regression analysis—a powerful statistical tool that investigates connections between multiple variables. By utilizing regression analysis, the study determined the influence of various independent variables on a dependent variable, enabling the identification of crucial factors affecting the dependent variable. This process facilitated the formulation of relevant models and interpretations of the elements under examination.

Through automated mathematical modeling, a linear model was constructed, using defense spending as the target variable and sustainable development indicators that demonstrated statistically significant connection with the target variable.

The primary aim of this paper is to assess how defense spending relates to sustainable development indicators in Romania during the period 2010-2021.

3.2. Model database descriptions

In this analysis, the chosen indicators play a crucial role in effectively monitoring the EU's progress towards achieving sustainable development objectives. Aligned with the sustainable development strategy firmly embedded in the European treaties and being a central focus of European politics for an extended period, these indicators serve as essential tools. The UN General Assembly's adoption of the 2030 Agenda for Sustainable Development (SDG) in 2015 has provided a renewed global drive, comprising 17 sustainable development goals, evaluating over 100 indicators. Each indicator emphasizes aspects that hold significance from the EU perspective, ensuring a comprehensive and informed assessment of sustainability efforts.

The selection of the indicators considered relevant for the analysis carried out is justified by the theoretical foundation confirmed by the foray into the specialized literature, as also emerges from the dimensions conceptualized in Figure no.1.

After careful consideration of these factors, sixteen indicators were chosen from the entire EUROSTAT database as the most pertinent for obtaining meaningful econometric results. These selected indicators are treated as independent variables in the investigation ($X_1, X_2,..., X_{16}$), while defense spending serves as the dependent variable (Y). The variables utilized in this analysis, which are presented in table no.1, were sourced from the EUROSTAT database. The chosen indicators for research were carefully selected, considering the dimensions of sustainable development, namely, economic, social, environmental, and mutual cooperation, taking into consideration the logical justifications at a theoretical level for their relevance to defense spending.

Table 1.Selected sustainable development indicators for the analysis

Variable	Indicator description	Measure	SD domains
Y	*General government expenditure by function (COFOG)*	Million euro	-
X_1	*Real GDP per capita*	Chain linked volumes (2010), euro per capita	Economic
X_2	*Investment share of GDP by institutional sectors*	% of GDP	Economic
X_3	*Employment rate*	% of population aged 20 to 64	Economic, social
X_4	*Resource productivity and domestic material consumption (DMC)*	Euro per kilogram, chain linked volumes (2015)	Economic, environmental
X_5	*Gender employment gap*	% of total population	Social, economic
X_6	*Final energy consumption*	Million tons of oil equivalent (TOE) per capita	Environmental, economic
X_7	*Energy productivity*	Euro per kilogram of oil equivalent (KGOE)	Environmental, economic
X_8	*Energy import dependency*	%	Environmental, economic
X_9	*Gross domestic expenditure on R&D*	% of GDP	Economic
X_{10}	*Human resources in science and technology*	% of active population	Economic
X_{11}	*R&D personnel by sector*	% of active population	Economic, social
X_{12}	*Purchasing power adjusted GDP per capita*	%	Economic, social
X_{13}	*Income distribution*	Purchasing power standard (PPS) per inhabitant	Mutual cooperation
X_{14}	*EU imports from developing countries*	Million euro	Mutual cooperation
X_{15}	*General government gross debt*	% of GDP	Mutual cooperation
X_{16}	*Share of environmental taxes in total tax revenues*	% of total taxes	Mutual cooperation

Source: https://ec.europa.eu/eurostat/web/sdi/database

The study focuses on the link between defence spending and sustainable development indicators. The research was undertaken with the help of the IBM SPSS 29v software, and the research results focus on the evolution of defence spending in Romania, in the period 2010-2021.

4. Research Results and Discussion

The descriptive analysis carried out helped to clarify the trends of defence spending in Romania in the period 2010 – 2021, and the implications of the 16 sustainable development indicators that were included in this study as independent variables.
Table no. 2 shows the results of the descriptive statistical analysis for the dependent variable, together with sixteen independent variables.

Table 2. Descriptive statistics of the variables

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Y	11	957,00	5169,00	2355,8182	1424,81555	,721	,661	-,537	1,279
x1	11	6340,00	9300,00	7682,7273	1049,71511	,410	,661	-1,445	1,279
x2	11	21,05	27,53	24,3227	2,04040	,195	,661	-,698	1,279
x3	11	56,00	65,20	60,0364	3,60285	,398	,661	-1,636	1,279
x4	11	,33	,50	,3939	,04795	1,034	,661	1,691	1,279
x5	11	16,70	19,30	17,8000	,84143	,927	,661	-,163	1,279
x6	11	1,09	1,23	1,1482	,05382	,508	,661	-1,548	1,279
x7	11	3,66	5,43	4,5773	,62506	-,140	,661	-1,214	1,279
x8	11	16,66	30,28	22,2361	4,30006	,514	,661	-,080	1,279
x9	11	,38	,50	,4609	,04061	-1,329	,661	,810	1,279
x10	11	24,00	28,40	26,5818	1,50055	-,335	,661	-1,383	1,279
x11	11	,33	,42	,3901	,02432	-1,475	,661	3,024	1,279
x12	11	13100,00	21800,00	16809,0909	3193,57309	,652	,661	-1,181	1,279
x13	11	6,11	8,32	6,9000	,61530	1,073	,661	1,886	1,279
x14	11	8654,00	15885,00	11462,7273	2676,67634	,674	,661	-1,247	1,279
x15	11	29,00	46,90	36,4727	4,50868	,878	,661	2,635	1,279
x16	11	6,89	9,27	7,9227	,73618	,521	,661	-,582	1,279
Valid N (listwise)	11								

Source: generated by SPSS

The results showed in the descriptive statistics showed that defence spending varied from 957 million euros to 5,169 million euros. Considering that it is important to correlate the evolution of defence spending (Y) with the sixteen sustainability indicators, Table no. 2 demonstrates the fact that the average figure of the defence expenditures made by the Romanian government reached 2,355.81 million euros, which is 14.01 percent of GDP per capita adjusted according to purchasing power, as X_{12} varied between 13,100 and 21,800 euros. Defence spendings seem also to be influenced by the adjusted gross disposable income for households per capita (X_{13}, average = 6,9 euros), which varied between 6,11 and 8,32 euros, and the real gross domestic product per capita (X_1), which varied between 6,340 and 9,300 million euros, with an average of 7,682 million euros in the analyzed period.

During the period from 2010 to 2021, the average employment rate (X_3) showed a gradual increase, reaching up to 60.03%. This upward trend had a significant impact on various indicators. Notably, the evolution of all examined indicators expanded positively:

- Final energy consumption (X_6) ranged from 1.09 to 1.23 million units;
- Energy productivity (X7) experienced growth, varying from 3.66 to 5.43 units;
- Dependence on energy imports (X8) fluctuated between 16.66% and 30.28%;
- Domestic expenditure on research and development (X9) ranged from 0.38% to 0.5%;
- Human resources in science and technology (X10) ranged from 24% to 28.40%;
- Research and development personnel by sector (X_{11}) varied from 0.33% to 0.42%;
- Gross public debt of the general government (X_{15}) fluctuated between 29% and 46.9%;
- The share of environmental taxes in total tax revenues (X16) ranged from 6.89% to 9.27%;

- The share of investments in GDP by institutional sectors (X2) varied from 21.05% to 27.53%;
- Resource productivity and internal material consumption (X4) ranged from 0.33 to 0.5 euro/kg.

These findings indicate a positive development across various sectors during the specified time frame, primarily driven by the steady increase in the average employment rate.

The study examined the connections between defence spending (Y) and sixteen indicators of sustainable development. Descriptive analysis revealed that the study variables did not follow a normal distribution (refer to Table no. 2). Consequently, a statistical analysis was conducted to determine the Spearman's rho correlation coefficients between the independent and dependent variables pertaining to Romania.

Spearman's rank correlation coefficient, also known as "Spearman's rho", is a statistical measure used to assess the strength and direction of the monotonic connection between two variables. It is a non-parametric measure that does not assume a linear dependence between variables, making it suitable for analysing ordinal or ordered data. The results of the correlation analysis are presented in Table no. 3.

Positive correlations were found between defence spending and the following indicators for which $p < 0.01$: gross domestic product (GDP) per capita (Y and X_1, $r = 0.80$); employment rate (Y and X_3, $r = 0.82$); the employment ratio between women and men (Y and X_5, $r = 0.81$); final energy consumption (Y and X_6, $r = 0.80$); energy productivity (Y and X_7, $r = 0.80$); dependence on energy imports (Y and X_8, $r = 0.75$); human resources in science and technology (Y and X_{10}, $r = 0.81$); GDP per capita adjusted for purchasing power (Y and X_{11}, $r = 0.79$); and EU imports from developing countries (Y and X_{14}, $r = 0.81$), and a value of $p < 0.05$ for gross domestic expenditure on research and development (Y and X_9, $r = 0.6$).

Furthermore, a negative correlation was observed between defence spending and the share of investment in GDP by institutional sectors (Y and X_2, $r = -0.73$, $p < 0.01$).
However, no statistically significant connections were found between defence spending and the following indicators for which $p > 0.05$: resource productivity and domestic material consumption (X_4); personnel in research and development by sector (X_{11}); income distribution (X_{13}); gross public administration debt (X_{15}); and the share of environmental taxes in total tax revenues (X_{16}). Consequently, these five sustainability indicators were excluded from subsequent investigations.

Table no. 3. Results of the Spearman's correlation coefficient analysis

			Y	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
Spearman's rho	Y	Correlation Coefficient	1,000	,800**	-,736**	,827**	-,248	,815**	,805**	,800**	,755**	,609*	,818**	,419	,797**	,045	,818**	-,023	,182
		Sig. (2-tailed)	.	,003	,010	,002	,462	,002	,003	,003	,007	,047	,002	,199	,003	,894	,002	,947	,593
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x1	Correlation Coefficient	,800**	1,000	-,836**	,982**	-,372	,796**	,713*	1,000**	,682*	,600	,964**	,710*	,989**	,445	,891**	,328	,255
		Sig. (2-tailed)	,003	.	,001	<,001	,259	,003	,014	.	,021	,051	<,001	,014	<,001	,170	<,001	,325	,450
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x2	Correlation Coefficient	-,736**	-,836**	1,000	-,827**	-,115	-,609*	-,538	-,836**	-,536	-,609*	-,755**	-,535	-,793**	-,364	-,764**	-,114	-,355
		Sig. (2-tailed)	,010	,001	.	,002	,736	,047	,088	,001	,089	,047	,007	,090	,004	,272	,006	,739	,285
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x3	Correlation Coefficient	,827**	,982**	-,827**	1,000	-,326	,847**	,685*	,982**	,682*	,558	,955**	,714*	,980**	,418	,827**	,383	,264
		Sig. (2-tailed)	,002	<,001	,002	.	,327	,001	,020	<,001	,021	,074	<,001	,014	<,001	,201	,002	,245	,433
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x4	Correlation Coefficient	-,248	-,372	-,115	-,326	1,000	-,394	-,321	-,372	-,170	-,181	-,455	-,273	-,403	-,299	-,418	-,396	,060
		Sig. (2-tailed)	,462	,259	,736	,327	.	,231	,336	,259	,617	,595	,159	,417	,219	,372	,200	,228	,861
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x5	Correlation Coefficient	,815**	,796**	-,609*	,847**	-,394	1,000	,551	,796**	,540	,389	,792**	,418	,803**	,476	,650*	,294	,435
		Sig. (2-tailed)	,002	,003	,047	,001	,231	.	,079	,003	,086	,237	,004	,201	,003	,139	,030	,381	,181
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x6	Correlation Coefficient	,805**	,713*	-,538	,685*	-,321	,551	1,000	,713*	,956**	,606*	,786**	,422	,751**	-,175	,855**	-,187	-,216
		Sig. (2-tailed)	,003	,014	,088	,020	,336	,079	.	,014	<,001	,048	,004	,196	,008	,607	<,001	,583	,523
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x7	Correlation Coefficient	,800**	1,000**	-,836**	,982**	-,372	,796**	,713*	1,000	,682*	,600	,964**	,710*	,989**	,445	,891**	,328	,255
		Sig. (2-tailed)	,003	.	,001	<,001	,259	,003	,014	.	,021	,051	<,001	,014	<,001	,170	<,001	,325	,450
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x8	Correlation Coefficient	,755**	,682*	-,536	,682*	-,170	,540	,956**	,682*	1,000	,503	,718*	,516	,715*	-,227	,736**	-,169	-,227
		Sig. (2-tailed)	,007	,021	,089	,021	,617	,086	<,001	,021	.	,114	,013	,104	,013	,502	,010	,620	,502
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x9	Correlation Coefficient	,609*	,600	-,609*	,558	-,181	,389	,606*	,600	,503	1,000	,632*	,077	,610*	,192	,719*	-,216	,183
		Sig. (2-tailed)	,047	,051	,047	,074	,595	,237	,048	,051	,114	.	,037	,823	,046	,571	,013	,524	,590
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x10	Correlation Coefficient	,818**	,964**	-,755**	,955**	-,455	,792**	,786**	,964**	,718*	,632*	1,000	,613*	,989**	,373	,918**	,328	,164
		Sig. (2-tailed)	,002	<,001	,007	<,001	,159	,004	,004	<,001	,013	,037	.	,045	<,001	,259	<,001	,325	,631
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x11	Correlation Coefficient	,419	,710*	-,535	,714*	-,273	,418	,422	,710*	,516	,077	,613*	1,000	,677*	,166	,479	,570	-,023
		Sig. (2-tailed)	,199	,014	,090	,014	,417	,201	,196	,014	,104	,823	,045	.	,022	,626	,136	,067	,946
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x12	Correlation Coefficient	,797**	,989**	-,793**	,980**	-,403	,803**	,751**	,989**	,715*	,610*	,989**	,677*	1,000	,419	,893**	,347	,214
		Sig. (2-tailed)	,003	<,001	,004	<,001	,219	,003	,008	<,001	,013	,046	<,001	,022	.	,199	<,001	,296	,527
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x13	Correlation Coefficient	,045	,445	-,364	,418	-,299	,476	-,175	,445	-,227	,192	,373	,166	,419	1,000	,255	,524	,609*
		Sig. (2-tailed)	,894	,170	,272	,201	,372	,139	,607	,170	,502	,571	,259	,626	,199	.	,450	,098	,047
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x14	Correlation Coefficient	,818**	,891**	-,764**	,827**	-,418	,650*	,855**	,891**	,736**	,719*	,918**	,479	,893**	,255	1,000	,032	,064
		Sig. (2-tailed)	,002	<,001	,006	,002	,200	,030	<,001	<,001	,010	,013	<,001	,136	<,001	,450	.	,926	,853
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x15	Correlation Coefficient	-,023	,328	-,114	,383	-,396	,294	-,187	,328	-,169	-,216	,328	,570	,347	,524	,032	1,000	,264
		Sig. (2-tailed)	,947	,325	,739	,245	,228	,381	,583	,325	,620	,524	,325	,067	,296	,098	,926	.	,432
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
	x16	Correlation Coefficient	,182	,255	-,355	,264	,060	,435	-,216	,255	-,227	,183	,164	-,023	,214	,609*	,064	,264	1,000
		Sig. (2-tailed)	,593	,450	,285	,433	,861	,181	,523	,450	,502	,590	,631	,946	,527	,047	,853	,432	.
		N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: generated by SPSS

To proceed with the statistical analysis using SPSS software, we included eleven sustainability indicators that showed statistical significance in relation to defence spending. To determine the correlation between defence spending (as the dependent variable) and the eleven statistically significant sustainability indicators, we selected them as independent variables. The SPSS software was employed, utilizing two statistical functions: the Automatic Linear Regression function (ALM), and Forward Stepwise Regression (FSR).
Furthermore, the study analyzes the dependencies between Romania's defence spending during the period 2010-2021 and sustainability indicators, available in SPSS.

In the initial analysis, the eleven indicators (X_1, X_2, X_3, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{12}, and X_{14}) were entered into the ALM function. Subsequently, the Forward Stepwise selection criterion was applied to select the most relevant variables. The Overfit Prevention Criterion was used to validate the data and avoid over-fitting.

Non-significant variables were excluded from the analysis, resulting in a final model with high accuracy (Information Criterion = 153.235). This model allowed for predicting defence spending using two sustainability indicators (X7 and X9).

The coefficient of determination, calculated using ALM, was found to be 0.797. This indicates that the two selected variables (X7 and X9) account for 79.70% of the changes in the target variable, while the remaining 20.30% is attributed to other factors not included in the model.

After running the ALM function, the results of the analysis present the effects of the two indicators (X_7 and X_9) by means of a graph, which contributes to a better visualization of the predictors of importance according to the positioning of the variables within the model, being listed from top to bottom in depending on the decrease of the effect, the higher line corresponding to the effects with a more significant value. Similarly, ALM presents the variables included in the model's significance ranking, achieved through ANOVA analysis. The effect for variable X_7, which represents energy productivity was high, according to the F-test (significance F X_7 = 0.883, $p < 0.005$), while for variable X_9 – which represents gross domestic expenditure on research and development, F – test identified a statistically significant effect (significance F X_9 = 0.117 $p < 0.206$).

The way in which sustainable development indicators (X_7 and X_9) influence defence spending is presented in Figure.2.

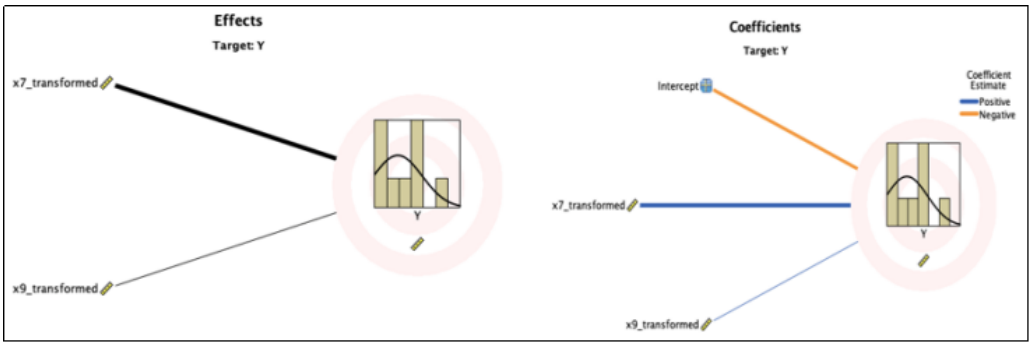


Figure 2. ALM analysis results
Source: generated bySPSS

Moreover, the ALM analysis provides the outcomes of the coefficients through both graphical representation and tabular format. The graphical representation arranges the model variables in descending order of their predictor importance, displaying the intercept first, followed by the others. The connecting lines in the graph are color-coded based on the coefficient's sign, with the line thickness reflecting the coefficient's significance.
After consolidating this data, we observe that the intercept has a negative sign, while sustainability indicators X_7 and X_9 exhibit positive coefficients, as depicted in Figure 2.

For more comprehensive information about the constructed FSR model, please refer to Table 4.

Table 4.The model generated by ALM for the indicators determined to be relevant in the study of the evolution of defence expenditure in Romania, in the reference period 2010 – 2021

Model Term	Coefficient ▼	Std.Error	t	Sig.	95% Confidence Interval		Importance
					Lower	Upper	
Intercept	-9,542.076	3,044.554	-3.134	.014	-16,562.830	-2,521.321	
x7_transformed	1,661.865	439.125	3.784	.005	649.242	2,674.488	0.883
x9_transformed	9,310.043	6,759.089	1.377	.206	-6,276.444	24,896.531	0.117

Source: generated by SPSS

The built regression model can be expressed by the following equation:

$$Y = -9{,}542.076 + 1{,}661.865 * X_7 + 9{,}310.043 * X_9$$

Y – represents defence expenditure – intercept is a constant in the model, X_7 – energy productivity and X_9 – gross domestic expenditure on research and development.

The equation's mathematical model underwent validation and demonstrated statistical significance. The accuracy of the model, designed to analyze defense expenses in Romania between 2010 and 2020 with respect to sustainable development indicators, was graphically validated using Figure 3.

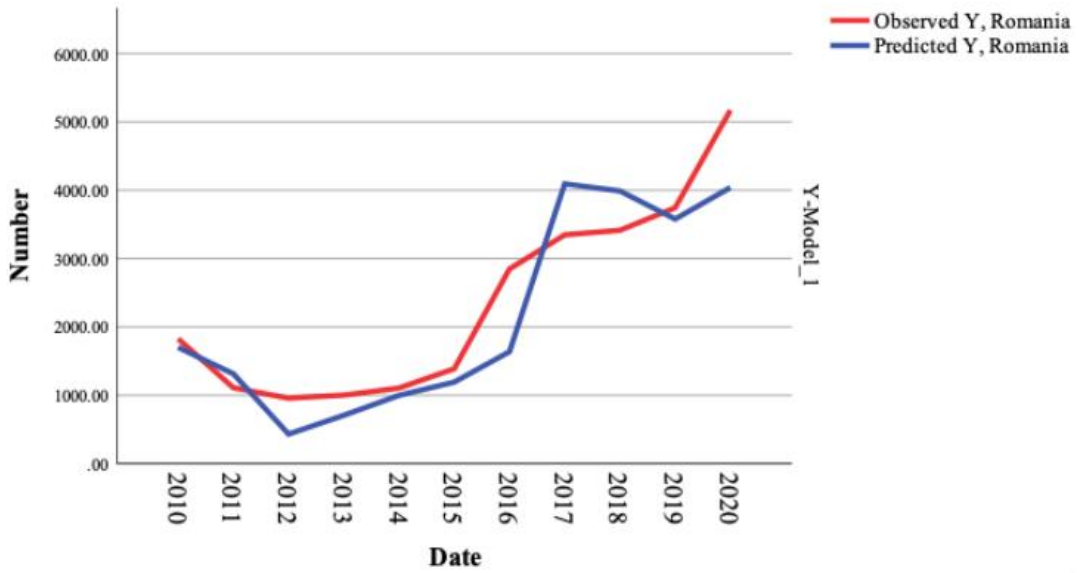


Figure 3. The evolution of defence spending in Romania, in the period 2010-2020
Source: generated by SPSS

The red line represents current defence spending and the blue line represents the prediction of defence spending, generated by the SPSS software, taking into account the two indicators of sustainable development (X_7 – energy productivity and X_9 – gross domestic expenditure on research and development).

The mathematical model identified as the most relevant variables X_7 – energy productivity and X_9 – gross domestic expenditure on research and development in support of defence expenditure, observing a strong interdependence between the way financial and material resources are created and distributed, facilitating sustainable development. The model generated by the SPSS software highlights the fact that the increase in defence spending is strongly influenced by energy productivity, due to the fact that the energy resource has a particular impact in supporting the research - development - innovation processes.

5. Conclusions

By running data within the program, it was particularly aimed at identifying a correlation between national defence spending and sustainable development indicators. Regarding the results of the regression analysis, positive links were identified between energy productivity and gross domestic expenditure on research and development in order to support defence expenditure, which is why, the current challenges and future prospects that are being configured in the sphere of the security environment and which increase the need for financial resources, especially in the field of endowment with high-performance military equipment and technology, generates an influence at both an economic and social level, through a sustainable social and economic development, which encourages

investments in defence and an approach from the perspective of resource sustainability intended for defence.

Energy productivity, which refers to the efficiency with which energy is used to produce goods and services, can have an impact on a country's overall economic stability. Higher energy productivity can lead to cost savings, improved industrial output, and enhanced economic growth. A stable and robust economy can, in turn, support higher defence expenditures as the government has more resources available for defence-related investments. Countries heavily reliant on imported energy resources may find themselves vulnerable to fluctuations in global energy prices or disruptions in supply. This resource dependence could lead to greater defence expenditures as nations seek to secure critical energy supply lines or protect strategic energy assets.

Improving energy productivity often involves technological advancements, such as energy-efficient infrastructure, renewable energy sources, and better energy management systems. Some of these technological developments might have dual-use applications, benefiting both civilian and military sectors. Defence expenditures might increase to leverage or develop these technologies for military purposes. Energy security is closely linked to national security. Ensuring a stable and secure energy supply is critical for a country's overall security. In some cases, defence expenditures may be directly allocated to protect energy infrastructure, like oil refineries, power plants, or pipelines, from potential threats.

The dependencies between energy productivity and defence expenditures can be influenced by a government's fiscal priorities. In certain situations, a government may choose to invest more in defence at the expense of other areas, including energy-related projects. Conversely, a focus on energy productivity might lead to reduced reliance on costly energy imports, freeing up resources that can be redirected to defence or other priorities.

Energy R&D and defence R&D are both significant drivers of technological innovation. Investments in energy R&D aim to improve energy efficiency, explore renewable energy sources, and develop cleaner technologies. On the other hand, defence R&D focuses on advancing military capabilities, weapons systems, and security technologies. However, certain technologies developed for one sector may have applications in the other. For example, advancements in materials science or information technology made for defence purposes could be adapted for use in energy-related industries.

Government budgets play a crucial role in determining the allocation of funds for different sectors, including energy R&D and defence. Countries with significant defence expenditures may prioritize military-related research and development over energy-related initiatives. Conversely, countries heavily investing in renewable energy and sustainable technologies might allocate fewer resources to defence R&D.

Defence spending growth is influenced by gross domestic spending on research and development. The gross internal expenditures for research and development do not particularly impact defence expenditures in Romania during the chosen reference period, but nevertheless, we believe that the major purchases that are carried out at the level of the entire army and the initiated research programs that have as a fundamental objective, the development of a resilient defence system capable of responding to the challenges of the

current security environment will generate a greater impact on defence spending in the near future.

Starting from the implications that defense expenditures in the Baltic countries have in achieving some objectives regarding sustainable development (Dudzeviciute, G.; 2021), we considered interesting the comparative analysis between them and the main aspects that emerge from the present research regarding the case of Romania.

The main conclusions from the cited research revealed several differences between the countries subjected to the study although their background is not very different. In Lithuania, the primary determinants influencing defense funding were identified as the employment rate and the proportion of R&D personnel within the active population. These factors accounted for roughly 88% of the variance in defense expenditure. Meanwhile, in Latvia, defense spending variations were primarily linked to the per capita gross disposable income of households and the portion of environmental taxes within the total tax revenue, jointly explaining around 82% of the fluctuations in defense expenditure. In the case of Estonia, the interplay of energy import dependency and the gross disposable income of households per capita emerged as significant drivers affecting defense spending trends. This combination of factors elucidated approximately 95% of the fluctuations in defense expenditure within the country. Drawing from the knowledge acquired during the study, the authors posit that during the timeframe spanning from 2000 to 2018, the allocation of funds for defense in the Baltic states was predominantly driven by political or strategic considerations, rather than economic ones.

Comparing the results obtained by the Baltic states, considering the economic sustainability generated by the allocation of public expenditures made with defense and ensuring national security and the results derived from the similar analysis carried out in the case of Romania, a series of differences can also be identified.

Romania is much larger in terms of both land area and population compared to each of the Baltic countries individually. Larger countries often have different defense needs and might allocate resources differently than smaller countries. Romania's defense budget might be more substantial than that of individual Baltic countries due to its larger economy and defense requirements. All four countries are members of NATO, but the specific contributions and commitments to the alliance might vary. NATO requires its member countries to spend a minimum of 2% of their GDP on defense, but not all member countries meet this target, some of them even exceed it.

Both the Baltic countries and Romania are located in Eastern Europe and share similar security concerns, primarily related to the perceived threat from Russia. The annexation of Crimea by Russia in 2014 and ongoing tensions in the region have led to increased attention and focus on defense and security matters, which also explains the increase in their defense budgets in recent years to address security challenges effectively.

All these aspects reinforce the conclusion that the allocation of defense expenses has strong political implications, but the relevance of the study consists in highlighting the importance that these expenses have when they are associated and corroborated with sustainable development and the achievement of the objectives subordinated to it.

Assessing defence expenditures in the context of sustainable development is of paramount importance in today's rapidly changing world. It provides insights into the potential trade-offs and synergies between security priorities and sustainability objectives. By critically examining the economic, social, and environmental implications of defence spending, policymakers can make informed decisions that promote both security and long-term sustainable development. This subject not only holds significance at the national level but also contributes to the global discourse on sustainable security, fostering a more resilient and inclusive future for all.

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