“Assessing the impact of military expenditures on economic growth: A case study of Azerbaijan”

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ASSESSING THE IMPACT OF MILITARY EXPENDITURES ON ECONOMIC GROWTH: A CASE STUDY OF AZERBAIJAN

Abstract

Analyzing the connection between military expenditure and economic growth is interesting due to its policy implications, particularly in geopolitically strategic regions. In the case of Azerbaijan, where defense spending accounts for a significant share of the national budget, this relationship is especially relevant. The present study explores the long-term equilibrium between military expenditure, expressed as a percentage of GDP, over a three-decade period marked by consistent economic growth and substantial defense investments. To investigate this relationship, the study applies the Johansen cointegration method to check for a stable long-term relationship. It employs the Granger causality test to determine the causal direction between the variables. The findings show cointegrating relationships, indicating a long-term equilibrium between military expenditure and economic growth. Furthermore, the Granger causality analysis indicates a bidirectional causal link, implying that changes in military expenditure influence GDP per capita growth and vice versa. Specifically, the results show that military expenditure Granger causes GDP per capita at a lag of 3 (p-value = 0.012). Similarly, GDP per capita Granger causes military expenditure at the same lag (p-value = 0.0001). The findings reveal the dual impact of military spending on economic development, providing insights for Azerbaijani policymakers to balance defense needs with economic growth.

Keywords military expenditure, economic growth, public management, GDP, econometrics, cointegration analysis, causality testing, Azerbaijan

JEL Classification E60, O11, O43, H59

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INTRODUCTION

In developing economies, particularly those facing regional security challenges, military spending is often regarded as vital for maintaining national security and stability. However, its economic impact remains contentious. While some studies argue that military expenditures can hinder economic growth by diverting resources from productive sectors, others suggest that it may promote growth through technological advancements, infrastructure development, and job creation.

Azerbaijan occupies a strategically complex geopolitical position. Pashayev (2007) has extensively elaborated on Azerbaijan's global geopolitical significance, highlighting its wealth of energy resources and its role as a crucial trade hub. Azerbaijan's recent substantial increases in military expenditure, influenced by regional security concerns and economic objectives, highlight a complex dynamic between defense spending and economic growth.

Since its independence in 1991, Azerbaijan has faced the occupation of approximately 20% of its territory. Resolving the Karabakh conflict

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became a crucial national objective, and the development of a strong military was considered essential. A robust economy was necessary to build an effective military. Consequently, over the past 30 years, Azerbaijan's military expenditures have surged in parallel with its economic development.

Military expenditures encompass spending on defense authorities, the army, and other bodies involved in defense-related activities. This includes both the import of military equipment and domestic production to meet defense needs, as well as potential export activities. In this context, such expenditures can also be considered investments, given their potential to contribute to both economic output and technological advancement. Military expenditures significantly affect the countries' socio-economic conditions and the regional power distribution (Jane & Ojaghlou, 2024). In 2023, Azerbaijan's military expenditure rose to USD 3.56 billion, up from USD 2.99 billion in 2022. This increase is part of a broader trend, with the country's military spending averaging USD 1.31 billion annually from 1992 to 2023 (Trading Economics, n.d.a). In the same year, Azerbaijan's Gross Domestic Product (GDP) was reported at USD 72.36 billion, which represents approximately 0.07 percent of the global economy (Trading Economics, n.d.b). Azerbaijan has continually elevated its defense spending to ensure its national security, demonstrating a strategic dedication to enhancing its military capabilities (Kazimbeyli, 2023). This increasing trend highlights the country's commitment to fortifying its armed forces in response to emerging security challenges and preserving stability.

Assessing the link between military spending and economic growth is crucial, particularly in contexts where defense expenditures represent a substantial portion of national budgets. This relationship is especially relevant for Azerbaijan, where prioritization of military spending persists in the face of ongoing geopolitical challenges. It is necessary to clarify the complex interplay between military expenditures and economic development, which is especially relevant for countries like Azerbaijan. The paper offers understandings that can guide policy decisions in Azerbaijan and similar contexts, where the challenge of reconciling national security with economic development remains critical.

1. LITERATURE REVIEW

Research has extensively analyzed the effect of military spending on economic development. Pieroni (2009) incorporated military and civilian government spending into an endogenous model to test the non-linear impact of military expenditure. The results demonstrate that the negative relationship between military spending and growth becomes substantial only when considering reallocative effects from shocks to insecurity. The robustness of these findings is confirmed through the use of non-parametric methods. Alptekin and Levine (2012) reviewed 32 sources comprising 169 estimates to investigate the connection between economic development and military expenditure. Their findings indicate no consistent evidence of a negative effect on growth in less developed countries, whereas a positive effect is observed in developed economies. In addition, they proved a non-linear relationship, with variations in results largely attributed to differences in sample characteristics, time periods, and methodological approaches. Furthermore, several articles offer an overview of the research topic, evaluating both its positive and negative effects (Dunne & Tian, 2013, 2016; Arshad et al., 2017).

Ahmed and Ismail (2015) conducted a comprehensive analysis by examining panel data of 56 countries from 1995 to 2011. Utilizing a fixed effects model, their findings indicate that while military spending does exert a positive influence on economic growth, this effect is relatively modest. More notably, the potential impact of reallocating military funds to non-military expenditures, especially in capital formation, far exceeds the benefits derived from military investment. This highlights the significant opportunity costs associated with defense spending, suggesting that resources could be utilized more effectively in sectors promoting economic development.

In contrast, Abdel-Khalek et al. (2020) did not prove a causal relationship between military expenditure and India's economic development dur-

Table 1. Brief overview of relationships between military expenditure and economic growth

Source	Year	Key findings
Yildirim et al. (2005)	2005	Military expenditure enhances economic growth in Middle Eastern countries
Gokmenoglu et al. (2015)	2015	Granger causality tests suggest a unidirectional effect of economic growth on military spending in Turkey
Zhong et al. (2017)	2017	Military spending has an effect on the US economic growth. Economic growth has an effect on military spending in Brazil and India
Lobont et al. (2019)	2019	There is a long-term bidirectional relationship between military expenditure and GDP, with positive effects observed in multiple models

ing the same period. Their research emphasizes that India's military strategy, shaped by ongoing regional conflicts, has primarily focused on enhancing military capabilities and achieving self-sufficiency alongside a robust military export sector. Further, Dimitraki and Ali (2013) explored the long-run causal correlation between the two constructs in China during 1952–2010 using a Barro-style growth model. Their application of a Bartlett-corrected trace test identified a single long-run equilibrium, indicating that fluctuations in military spending are predominantly responses to economic development shocks rather than drivers of economic growth. Additional research in Pakistan (Ajmair et al., 2018), Nigeria (Ajala & Laniran, 2021), and South Africa (Phiri, 2019) provided evidence of the multifaceted impact of military expenditure on economic growth across diverse regional contexts. Collectively, these studies enhance the understanding of the complex dynamics between the two notions, illuminating the implications of defense expenditure within various national settings.

Recent studies generally suggest that military spending tends to hinder economic growth. However, evidence from certain regions and specific cases shows its possible beneficial effect, underscoring the nuanced nature of this topic. Table 1 shows examples of articles demonstrating a positive relationship between economic performance and military spending.

Research on the Azerbaijani context is limited. Some articles as Yildirim and Öcal (2016) found both direct and indirect effects of military spending on economic performance, with external factors such as oil revenue and geopolitical tensions playing significant roles.

Therefore, this study aims to determine whether there is an interplay between military expenditure and Azerbaijani economic performance, offering an in-depth analysis of how these dynamics unfold in this unique environment. To guide this investigation, two hypotheses have been established:

H1: Military expenditure positively influences GDP per capita in Azerbaijan.

H2: GDP per capita positively affects military expenditure in Azerbaijan.

2. METHODOLOGY

Using a structured method, this paper aims to analyze the relationship between Azerbaijani economic development and military spending. It employs unit root tests, specifically the Augmented Dickey-Fuller (ADF) test, to assess the stationarity of the variables. The Johansen cointegration test is then applied to analyze the long-term equilibrium between military expenditures and economic growth. Lastly, the Toda-Yamamoto and Granger causality tests are utilized to determine the direction of causality between military spending and GDP per capita.

The study focused on understanding the long-term and causal interactions between these variables. Vector Autoregression (VAR) models were utilized, incorporating Johansen's cointegration method (Johansen, 1988) to evaluate long-term equilibrium relationships and the Toda-Yamamoto causality test (Toda & Yamamoto, 1995) to identify potential causal connections. GDP per capita, a crucial indicator of economic development, was central to the analysis.

The study uses the World Bank (n.d.) database to retrieve military spending and GDP per capita data. To enhance the precision and statistical validity of the analysis, logarithmic transformations were

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Source: World Bank (n.d.).

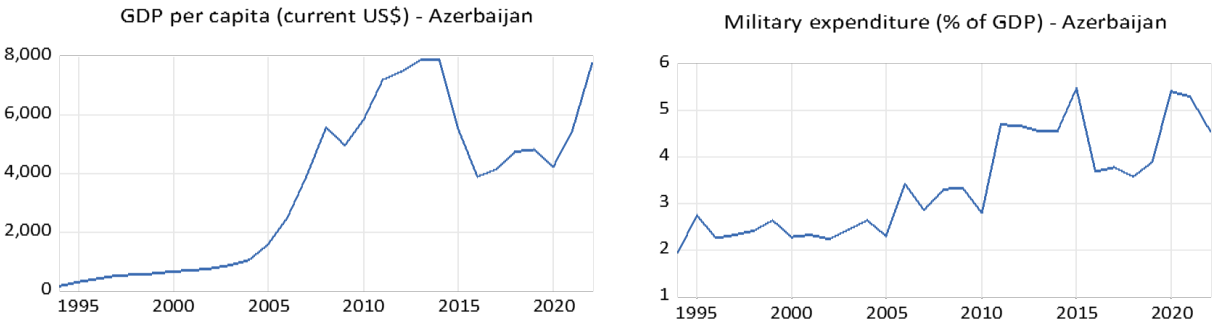


Figure 1. GDP per capita and military expenditure in Azerbaijan: 1994–2022

Table 2. Overview of data analysis

Variables	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis
LGDPPC	7.661	8.263	8.973	5.056	1.184	–0.545	1.902
LMIL	1.170	1.191	1.698	0.666	0.315	0.218	1.708

Note: LMIL = military expenditure (% of GDP); LGDPPC = GDP per capita.

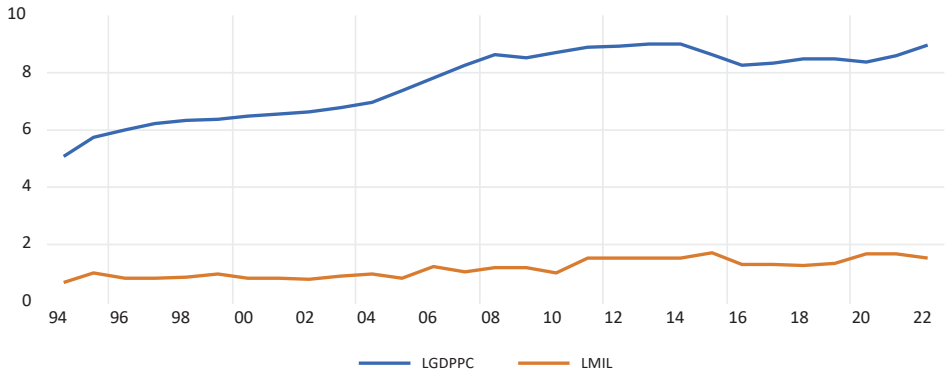
applied to both variables, improving their interpretability and addressing issues related to scale and variance.

The study analyzed annual data from 1994 to 2022. Figure 1 illustrates that since the mid-2000s, Azerbaijan has experienced substantial growth in GDP per capita and military expenditure, largely driven by increased oil and gas revenues.

Table 2 provides a detailed statistical summary of these data for Azerbaijan, highlighting the logarithmic transformations of military expenditure and GDP per capita. This summary thoroughly examines the distribution and properties of these transformed variables over the specified period.

Figure 2 presents line graphs illustrating the logarithmic transformations of military expenditure and GDP per capita. These graphs demonstrate a consistent upward trend in the logarithmic variables, indicating a steady rise in both military expenditure and GDP per capita over the observed period. The persistent upward movement reflects the continuous growth of these economic indicators throughout the timeframe studied.

Further, the study proceeded to check whether one time series can predict or provide insights into another time series using the Granger causality test (Granger, 1969). This test is particularly significant in various economic fields as it facilitates the identification of causal relationships between



Note: LMIL = military expenditure (% of GDP); LGDPPC = GDP per capita.

Figure 2. Logarithmic time series profile of variables

variables over time. The Johansen cointegration method for analyzing long-term economic relationships has established the test for cointegrating rank as an essential econometric tool (Johansen, 2002). This approach allows for the evaluation of multiple cointegration relationships among variables, thereby deepening the understanding of their long-run equilibrium dynamics.

The Toda-Yamamoto test mitigates several limitations of the Granger causality test by effectively handling time series with different orders of integration. Unlike the conventional Granger causality test, which requires variables to be either stationary or to share the same integration order, the Toda-Yamamoto test can accommodate variables with varying levels of integration. This flexibility enhances the ability to evaluate causal relationships among time series that may exhibit diverse integration characteristics, offering a more robust and versatile framework for analyzing directional influences and causal dynamics. This methodology adheres to a specific methodological trajectory for evaluating parameter significance in a VAR model.

The Modified Wald statistic is employed through a series of steps to achieve this. First, the maximum order of integration (denoted as d_{max}) for the time series is determined. Next, the optimal lag length (k) for the VAR model is established. With these values identified, a VAR model of order ($k + d_{max}$) is estimated to ensure that the Wald statistic follows an asymptotic chi-square distribution. Finally, hypothesis testing is performed using the standard Wald statistic test, with the results assessed against a chi-square distribution. The Toda and Yamamoto (1995) causality test formulas can be outlined as follows:

$$LY_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i LY_{t-i} + \sum_{j=k+1}^{d\max} \alpha_j LY_{t-j} + \sum_{i=1}^{k} \phi_i LE_{t-i} + \sum_{j=k+1}^{d\max} \phi_j LE_{t-j} + \nu_{1t}, \quad (1)$$

$$LE_t = \beta_0 + \sum_{i=1}^{k} \beta_i LE_{t-i} + \sum_{j=k+1}^{d\max} \beta_j LE_{t-j} + \sum_{i=1}^{k} \delta_i LY_{t-i} + \sum_{j=k+1}^{d\max} \delta_j LY_{t-j} + \nu_{2t}, \quad (2)$$

where LY and LE represent the variables transformed using logarithms for *LMIL* and *LGDPPC*, respectively. The parameter k signifies the optimal lag length, while d denotes the maximum order of integration in the series. Furthermore, ν_{1t} and ν_{2t} are the error terms included in the model equations.

3. RESULTS

The estimation of causal relationships between economic variables is a fundamental objective of econometric analysis. In this context, GDP per capita serves as the dependent variable and military expenditure (% of GDP) as the independent variable for *H1*, whereas the variables are reversed for *H2*, with military expenditure (% of GDP) becoming the dependent variable and GDP per capita the independent variable. The purpose of the calculations is to test stationarity, assess correlation, conduct causality analysis, and ensure the robustness and reliability of the VAR model through diagnostic tests. To minimize the risk of spurious correlations, a range of methodological approaches has been developed. A critical prerequisite for establishing causality is the pre-testing of time series properties, particularly in determining the order of integration and selecting an appropriate lag length, which are essential components of the econometric modeling process. The preliminary analysis focused on determining the stationarity properties of the series. To achieve this, the Augmented Dickey-Fuller (ADF) test, as proposed by Dickey and Fuller (1981), was employed.

Table 3 shows that one of the variables is non-stationary at levels when using models with an intercept and trend. However, the series becomes stationary after being differenced. This finding suggests that the variables are integrated into order two, denoted as I(2). Consequently, the maximum order of integration within the system, d_{max}, is determined to be two.

The next phase involved determining the optimal lag length (p) for the Vector Autoregression (VAR) model. Several information criteria were utilized to achieve this, as specified in Table 4. An initial VAR model incorporating all endogenous variables was estimated using a randomly selected lag

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interval. To refine this specification, a sequential testing procedure was performed on the residuals to identify the most appropriate lag length. A statistical analysis determined the optimal number of lags for a VAR model, indicating a preference for a lag length of 3 across multiple criteria.

Table 3. ADF unit root tests

Trend and Intercept	t-statistics	p-value
LGDPPC		
Level	–1.627	0.754
1st difference	–2.991	0.152
2nd difference	–4.676	0.005*
LMIL		
Level	–3.801	0.031*
1st difference	–7.938	0.000*

Note: * The maximum and optimal lag order (k) are determined using the Schwarz criterion within the Augmented Dickey-Fuller (ADF) test. Critical values from MacKinnon (1996) are utilized for the ADF tests. The results indicate a rejection of the null hypothesis. LMIL = military expenditure (% of GDP); LGDPPC = GDP per capita.

Table 4. VAR lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
LGDPPC LMIL						
0	–22.590	NA	0.026609	2.049	2.147	2.075
1	17.237	69.698	0.001347	–0.936	–0.641	–0.858
2	21.938	7.442	0.001283	–0.994	–0.503	–0.864
3	30.018	11.447*	0.000934*	–1.334*	–0.647*	–1.152*
4	31.086	1.335	0.001244	–1.090	–0.207	–0.856
5	33.988	3.142	0.001463	–0.999	0.080	–0.712

Note: * denotes the lag order selected by the criterion. LR = Likelihood Ratio; FPE = Final Prediction Error; AIC = Akaike Information Criterion; SC = Schwarz Criterion; HQ = Hannan-Quinn (HQ) criterion. LMIL = military expenditure (% of GDP); LGDPPC = GDP per capita.

Figure 3 visually demonstrates the stability condition for an autoregressive (AR) model, which is crucial for ensuring the reliability of time series analysis. The model's stability is confirmed by the positioning of all inverse roots of the AR characteristic polynomial within or on the unit circle. This condition is necessary for making valid inferences from the model's results.

The integrity of the VAR model was evaluated through a series of diagnostic tests. Serial correlation LM tests were used to identify autocorrelation in the residuals, while normality and White heteroskedasticity tests were performed to assess the distribution and variance of the error terms. The absence of autocorrelation, normality of residuals, and homoscedasticity are essential for ensuring efficient parameter estimation, valid inference, and reliable forecasting. By confirming these assumptions, the model's specification is reinforced, thereby enhancing the accuracy of hypothesis testing and policy analysis. Table 5 presents key findings concerning the VAR model, illustrating the residuals' stability and temporal independence, as indicated by the absence of serial correlation. Furthermore, it verifies the model's reliability by showing no significant deviations from normality or heteroskedasticity, thus supporting its appropriateness for rigorous statistical inference.

Table 6 presents the results of the Johansen cointegration test, which assesses whether a long-term relationship exists between time series variables such as military expenditure and GDP per capita

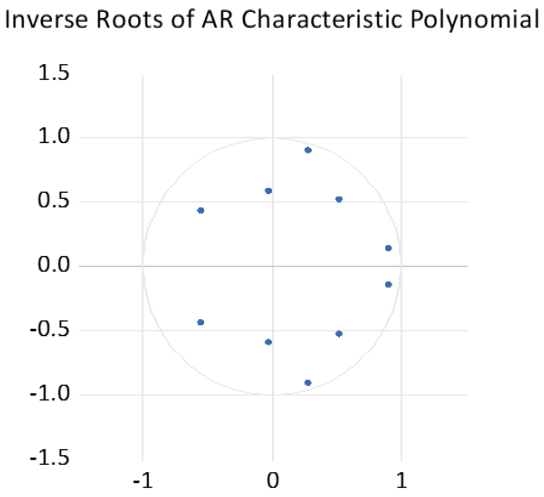

Figure 3. Inverse roots of AR characteristic polynomial

Table 5. VAR residual tests

Serial Correlation LM Tests			
Lag	**LRE stat***	**df****	**p-value**
1	4.302	4	0.366
2	0.911	4	0.922
3	3.709	4	0.446
4	7.488	4	0.112
5	3.122	4	0.537
6	5.850	4	0.210
Diagnostics			
Normality Test			
Component	**Jarque-Bera**	**df**	**p-value**
Joint	1.651	4	0.799
Heteroskedasticity Test			
White	χ^{2***}	df	p-value
Statistic	66.11	60	0.274

Note: * Edgeworth expansion-adjusted likelihood ratio statistic. ** df denotes the degrees of freedom. *** χ^2 represents the Chi-squared value.

in Azerbaijan. The findings indicate that, with a *p*-value of 0.024 and a trace statistic of 17.541 exceeding the critical value of 15.494, the null hypothesis of "no cointegration" is rejected, suggesting the presence of at least one long-run relationship between the variables.

The final stage of the analysis, utilizing the Toda-Yamamoto causality test, reveals a bidirectional causal relationship between military expenditure and gross domestic product per capita in Azerbaijan. As detailed in Table 7, the null hypotheses of no Granger causality in either direction are rejected at the 5% significance level. This empirical evidence supports the conclusion that fluctuations in military expenditure and economic growth have a mutually influential relationship. The study's hypotheses were designed to examine the bidirectional relationship between military expenditure and economic growth. The Toda-Yamamoto Granger causality results confirm mutual causation by rejecting the null hypotheses in both directions.

4. DISCUSSION

This study analyzed the effect of military expenditure on economic development in Azerbaijan, revealing the multifaceted role of defense spending. The findings emphasize that military expenditure is not solely a national security tool but also a significant form of government investment with notable economic implications. In Azerbaijan, military spending contributes to economic growth

Table 6. Cointegration rank test

Null hypothesis	Eigenvalue	Trace Statistic	0.05 Critical value	P-value
None*	0.454	17.541	15.494	0.024
At most 1	0.145	3.614	3.841	0.057

Note: * Denotes rejection of the hypothesis at the 0.05 level.

Table 7. Toda-Yamamoto Granger causality test results

Null hypothesis	Lag (k)	$k + d_{max}$	Chi-squared test	Conclusion
Military Expenditure (LMIL) does not Granger cause Gross Domestic Product Per Capita (LGDPPC)	3	5	10.776 (0.012*)	Reject
Gross Domestic Product Per Capita (LGDPPC) does not Granger cause Military Expenditure (LMIL)	3	5	20.300 (0.0001*)	Reject

Note: * Statistically significant at the 5% level.

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through three primary channels: military exports, technological advancements, and job creation. First, the expansion of the military export sector strengthens Azerbaijan's geopolitical power and generates revenue, enhancing the country's economic profile. Second, investments in military technology spur innovation, leading to advancements that spill over into civilian sectors, thus boosting productivity and improving global competitiveness. Finally, defense spending creates employment opportunities both within the defense sector and in related industries, fostering wider economic growth and stability.

The Military-Industrial Complex Hypothesis suggests that military spending can foster technological innovations and infrastructure development, which, in turn, benefit the civilian economy. This represents one of the instances where significant scholarly attention has been devoted to exploring the implications of the hypothesis (Dunne & Sköns, 2014; Coyne & Goodman, 2022). The Ministry of Defense Industry's efforts to reduce reliance on imports by establishing a domestic system for military production have proven to be a strategic move aimed at fulfilling national defense needs while simultaneously stimulating economic activity. This initiative not only enhances Azerbaijan's defense capabilities but also drives technological development and creates new export opportunities. In 2022, Azerbaijan exported over USD 3 million in military products, mainly to markets in Nigeria, Turkey, and the United States (OEC, n.d.). These exports not only contribute directly to the national economy but also reflect the country's growing position within the global defense sector. Additionally, the country's focus on modernizing its military infrastructure, including the development of advanced military products, demonstrates how defense spending can drive technological innovation and industrial growth, contributing to a diversified economy (Azertag, 2024).

In alignment with Samuelson's (1948) "guns versus butter" framework, the study suggests that military expenditure, while often viewed in opposition to social sector investments, can catalyze economic growth in specific contexts. This perspective is further supported by Barro's (1990) argument that military spending can have positive spillover effects on economic development, particularly when it leads to technological advancement and job creation. The relationship between military expenditure and GDP in Azerbaijan, as revealed by the Johansen cointegration and Granger causality tests, underscores the bidirectional nature of this connection. Although it is widely recognized that economic growth impacts defense spending, this study emphasizes the frequently overlooked reciprocal effect, where military expenditure also contributes to economic growth. This dual relationship is particularly evident in the ways investments in defense infrastructure and the local production of military equipment stimulate various sectors, generate export opportunities, and strengthen industrial capacities. This investigation introduces a novel perspective into the Azerbaijani context and significantly contributes to global scientific discourse by examining the economic implications of defense spending. Future research could further explore the long-term sustainability of Azerbaijan's military spending and its broader economic impacts, particularly by assessing how defense investments affect other sectors and whether there are potential trade-offs between military spending and socio-economic welfare. Such research could provide valuable insights into optimal budget allocation strategies that ensure both national security and sustainable economic growth.

The results emphasize the necessity for Azerbaijani policymakers to strike a balance between military spending and investments in key sectors. Moreover, given the country's dependence on oil revenues, it is essential for the government to focus on diversifying the economy to reduce exposure to global oil price fluctuations, thereby ensuring that military expenditures do not undermine other developmental priorities.

CONCLUSION

The paper aimed to assess the effect of military spending on economic performance in Azerbaijan, focusing on the interplay between defense spending and GDP per capita. The econometric analysis revealed a robust long-term equilibrium relationship between the two variables, as evidenced by the Johansen cointegration test that identified at least one cointegrating relationship. Additionally, the Granger cau-

sality test established a bidirectional causal relationship, indicating the mutual relationship between economic growth and military expenditure. These results underscore the reciprocal nature of this correlation, providing significant insights for policymakers.

This study contributes contextual applications of its findings to Azerbaijan, a region where the dynamics of military expenditure and economic growth have not been extensively studied. The practical implications suggest that policymakers should carefully balance military expenditures with investments in other critical sectors to promote sustainable economic growth. Further research may incorporate other variables, such as external influences and oil revenues, to enrich the understanding of the relationships between economic performance and military expenditures.

AUTHOR CONTRIBUTIONS

Conceptualization: Ramil Hasanov, Zeynab Giyasova, Mustafa Kemal Oktem, Vusal Guliyev, Rashad Salahov.
Data curation: Ramil Hasanov.
Formal analysis: Ramil Hasanov, Zeynab Giyasova, Mustafa Kemal Oktem, Vusal Guliyev, Rashad Salahov.
Funding acquisition: Zeynab Giyasova.
Investigation: Ramil Hasanov, Zeynab Giyasova, Mustafa Kemal Oktem, Vusal Guliyev.
Methodology: Ramil Hasanov, Mustafa Kemal Oktem, Rashad Salahov.
Resources: Ramil Hasanov, Zeynab Giyasova.
Software: Ramil Hasanov, Zeynab Giyasova.
Supervision: Ramil Hasanov, Mustafa Kemal Oktem, Vusal Guliyev.
Validation: Zeynab Giyasova, Mustafa Kemal Oktem, Vusal Guliyev, Rashad Salahov.
Visualization: Rashad Salahov.
Writing – original draft: Ramil Hasanov, Zeynab Giyasova.
Writing – review & editing: Ramil Hasanov, Zeynab Giyasova, Mustafa Kemal Oktem, Vusal Guliyev, Rashad Salahov.

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