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Research Article

Rethinking The Defense–Growth Nexus: Evidence from Türkiye

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Abstract

Allocating a portion of national income to defense spending can have varying impacts on the economy. This issue has been the subject of extensive academic debate, with numerous studies analyzing the connection between defense expenditure and economic growth through a range of methodological approaches. However, a consensus has yet to be reached among scholars regarding whether such spending promotes or inhibits economic development. This study aims to investigate the potential effects of defense expenditures on economic growth in Türkiye from 1990 to 2021, employing Barro's (1990) theoretical framework. The analysis utilizes the autoregressive distributed lag (ARDL) approach and the Bayer-Hanck (2013) cointegration method to examine the relationship between the variables. Furthermore, the ARDL and dynamic ordinary least squares (DOLS) models are employed to estimate the long-term coefficients. The empirical findings indicate that defense expenditures exert a negative impact on economic growth. In contrast, population growth, human capital, and gross fixed capital investment demonstrate a positive and statistically significant relationship with economic growth.

Keywords: Barro (1990) Model, Defense Expenditure, Economic Growth, Time Series Analysis

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1. Introduction

Maslow's (1943) hierarchy of needs theory conceptualizes physiological needs as fundamental necessities, encompassing "security needs". According to Maslow (1943), the fulfillment of security needs enables individuals to interact effectively within society (Şengöz, 2022). In this context, governments allocate a portion of their defense expenditures to the establishment and maintenance of armed security forces to safeguard their citizens (Dunne et al., 2008). From this perspective, ensuring both internal and external security represents a fundamental responsibility of the state (Öztekin, 2015).

A fundamental responsibility of the state is to ensure both internal and external security by providing defense services, which are classified as pure public goods. Public goods supplied by the state are characterized by non-rivalry and indivisibility, meaning they are accessible to all citizens without exclusion (Barış and Barlas 2017). Allocations for defense services constitute a significant component of public expenditures, often accounting for a considerable share of the national budget and exerting an influence on macroeconomic dynamics (Taşdelen, 2022).

The role of the state in economic affairs and its potential impact on economic growth has been a longstanding subject of scholarly debate. Classical and neoclassical economists argue that the state's involvement in the economy should be minimal, limited to essential functions such as diplomacy, justice, maintaining public order, and providing infrastructure services. In contrast, Keynesian growth theory advocates for a more active role of the state, asserting that increased public expenditure contributes positively to economic growth (Sen, 2007).

Endogenous growth models suggest that economic growth is primarily driven by intrinsic market factors while recognizing the diverse roles the state can play in fostering long-term development (Ercan, 2002). Romer (1986) underscores the significance of state policies in supporting the R&D sector, which generates broader societal benefits. Similarly, Lucas (1988) emphasizes the state's critical role in allocating a larger share of public expenditures to education, thereby increasing enrollment rates and promoting human capital development. Additionally, Lucas highlights the importance of state-supported R&D initiatives, patent systems, and mechanisms to safeguard intellectual property rights as fundamental drivers of innovation and economic growth (Sen, 2007).

The relationship between defense expenditure and economic growth has been a subject of ongoing debate among economists. According to the Stockholm International Peace Research Institute (SIPRI) (2023), global defense expenditure has reached unprecedented levels, highlighting the significance of this relationship. Various theoretical perspectives seek to explain this connection, including Military Keynesianism and the neoclassical economic approach (Dunne et al., 2001; Hacılıoğlu, 2004).

The Military Keynesian perspective argues that increased defense spending generates positive externalities in key sectors such as education, technology, infrastructure, and industry, thereby stimulating economic growth (Benoit 1973; Yıldırım et al. 2005; Wijeweera and Webb 2011; Şimşek and Öcal 2016). More broadly, Keynesian theory suggests that defense expenditure enhances aggregate demand through a multiplier effect, subsequently expanding production capacity and fostering economic growth (Abu-Bader and Abu-Qarn 2003).

Conversely, the neoclassical approach posits that increased defense expenditure may adversely impact economic growth by crowding out private investment and more productive public sector expenditures (Looney 1995; Dunne et al., 2005). Neoclassical theorists contend that scarce resources should be allocated to sectors such as education and healthcare, as channeling them into defense spending may generate negative externalities (Bright 2016). Moreover, diverting resources away from productive investments toward defense expenditures may impede human capital accumulation, thereby constraining long-term economic growth (Looney 1995). Empirical evidence supporting this perspective is found in studies conducted by Galvin (2003), Mylonidis (2008), and Chang et al. (2011).

Various models have been employed to analyze the relationship between defense expenditure and economic growth, including the extended Solow model, the Feder-RAM model, and the Barro model (Dunne et al. 2005). Seminal work initiated extensive research on this relationship; however, the literature remains inconclusive regarding both the direction and magnitude of the effect (Benoit's 1973; Benoit's 1978). This study investigates the relationship between defense expenditure and economic expansion in Türkiye using the Barro-type growth model, the ARDL approach (Pesaran et al., 2001), and the Bayer-Hanck cointegration method (Bayer and Hanck, 2013).

Feder (1983) developed a supply-oriented model to analyze the effects of exports on economic growth by dividing underdeveloped countries into export and non-export sectors. In an alternative study, Feder (1983) introduced a model aimed at exploring the relationship between military expenditure and economic growth in less developed countries (Sezgin, 1997).

Additionally, Ram (1986) and Biswas and Ram (1986) proposed a model that explains the positive link between defense expenditures and growth through two primary mechanisms: (1) defense expenditures positively contribute to overall economic performance, and (2) the defense sector exhibits higher efficiency relative to other sectors. As a result, reallocating resources toward the highly efficient defense sector can enhance overall economic growth (Başar and Künü 2012).

The Feder-Ram model conceptualizes the economy as being composed of two distinct sectors: the defense sector (M) and the civilian, non-defense sector (C) (Sezgin, 1997). Based on this framework, the total output of the economy and the total production function can be represented as follows:

$$Y = Y_C + Y_M \tag{1}$$

$$M = M(K_M, L_M) \tag{2}$$

$$C = C(K_C, L_C, M) \tag{3}$$

As indicated in equations (1), (2) and (3) "Y_C" is the output of the civilian (non-defense) sector, "Y_M" is the output of the military (defense) sector, "K" represents the stock of capital while "L" represents labor. Although both sectors utilize homogeneous labor and capital, the model also incorporates the external effects of military production on civil production and acknowledges differences in factor productivity (Biswas and Ram 1986). In addition to the separate production functions for the defense sector (M) and the non-defense civil sector (C), the total output (Y) produced from labor (L) and capital (K) inputs is represented as follows (Ram 1995):

$$L = L_M + L_C, \; K = K_M + K_C, \; Y = M + C \tag{4}$$

The model separates labor inputs into ML for the military sector and CL for the civilian sector, and capital inputs into MK for military use and CK for civilian use. This classification is designed to demonstrate how military production influences the civilian sector differently and to emphasize the structural distinctions between the two sectors (Biswas & Ram, 1986; Atilla, 2019).

$$M'K \,/\, C'K = M'L \,/\, C'L = 1 + \delta \tag{5}$$

In equation (5), the two-sector Feder–Ram model is presented. Here, "δ" represents the difference in factor productivity, "C_M" denotes the impact of defense expenditures on the civil sector, "Ỳ" stands for total output, "I/Y" represents the ratio of investments contributing to economic growth, and "M/Y" indicates the ratio of defense expenditures to GDP. On the other hand, when the differential productivity factor of defense expenditures is separated from the externality effect using (θ), the model takes the form of the threshold equation (8) (Biswas and Ram 1986).

$$\grave{Y} = a(I/Y) + \beta(\acute{L}) + \left(\frac{\delta}{1+\delta} C_M\right)(\dot{M}(M/Y)) \tag{6}$$

$$\grave{Y} = a(I/Y) + \beta(\acute{L}) + \left(\frac{\delta}{1+\delta} + C_M\right)(\dot{M}(M/Y)) \tag{7}$$

$$\grave{Y} = a(I/Y) + \beta(\acute{L}) + \left(\frac{\delta}{1+\delta} + \theta\right)(\dot{M}(M/Y)) + \theta\,\dot{M} \tag{8}$$

Variants of equations (7) and (8) have been estimated using cross-sectional country data (Biswas and Ram 1986), country-specific time series data (Huang and Mintz 1991; Ward et al. 1993; Sezgin 1997), and panel data (Murdoch, Pi and Sandler 1997) (Dunne et al. 2005). The theoretical and econometric weaknesses of the Feder–Ram model are as follows (Dunne et al. 2005; Atilla 2019):

1. The differences in marginal factor productivity across sectors, as specified in Equation (6), give rise to interpretational issues. In econometric studies, a non-zero estimated "δ" leads to an interpretation where one sector is seen as "less efficient" or "less effective" than the other.

2. There are difficulties in calculating the inter-sectoral organizational inefficiencies inherent in the model's structure.

3. Another weakness stems from the econometric specification of the regression equations. In equations (7) and (8), it is unclear which factors influence the error term, and there is no variable representing technological progress apart from the military externality.

4. In the Feder-Ram equation, placing defense expenditures on the right-hand side leads to an over-determination issue. This is because, even if the defense expenditure variable is held constant, the resulting increase in total output may still be driven by defense expenditures.

5. The last two variables in this model may lead to multicollinearity, resulting in large standard errors and erroneous estimates of the externality parameter. Moreover, in time series analysis, the lagged values of total output are an important determinant of growth; the absence of lagged variable terms further complicates the model.

The Feder-Ram model, originally developed by Ram (1986) and Biswas and Ram (1986), has been extensively examined within the empirical literature investigating the nexus between defense expenditure and economic growth (Alexander, 1990; Alexander, 1995; Ward et al., 1991; Huang & Mintz, 1990; Sezgin, 1997). Critiques of its theoretical and econometric foundations have resulted in the development of several alternative specifications (Heo, 2010).

Feder (1983) developed an approach that was widely used to explain the relationship between exports and growth as well as public expenditures and growth; however, it is now seldom used outside of studies on defense expenditures and growth (Dunne et al. 2005). In 1992, Mankiw, Romer, and Weil introduced a new model by incorporating human capital into the Solow growth model, which is referred to as the “Extended Solow Model” (Mankiw et al. 1992). The main reason for including human capital in this model was to clarify the impact of savings and population on growth, as their effects were not fully understood despite the inclusion of human capital in savings and population variables. Therefore, incorporating human capital allowed for a better understanding of these dynamics (Hacıbebekoğlu 2019).

The Extended Solow Model was first employed to determine the impact of defense expenditures on growth by Knight et al. (1996). Its fundamental assumption is that the defense expenditure share, denoted by the series m = M/Y, affects growth through a productivity parameter that controls labor-augmenting technological change (Dunne et al. 2005). This model is derived from the neoclassical aggregate production function (Auger et al. 2017; Atilla 2019).

$$Y(t) = K(t)^{a}[A(t)L(t)]^{1-a} \tag{9}$$

In the equation above (9), “Y” denotes total real output, “K” represents the real capital stock, “a” is partial productivity, “L” indicates labor, and “1 – α” corresponds to the partial productivity of labor. “A” stands for the technological progress coefficient. The technological progress coefficient has been re-derived to encompass the externalities of defense expenditures as follows.

$$A(t) = A0e^{gt}\, m(t)^{\theta} \tag{10}$$

The model incorporates the exogenous Harrod-neutral rate of technological progress, denoted as“e^{gt}” which represents the share of defense spending in GDP. According to Equation (10), a permanent shift in the military expenditure ratio does not affect long-run growth but may lead to a short-run rise in per capita income. A defense-inclusive variant of the Extended Solow Model is represented in Equation(11)(Heo 2010).

$$\Delta lny(t) = \beta_0 + \beta_1 ln\, y(t-1) + \beta_2\, ln\, s + \beta_3\, ln(n+g+d) + \beta_4\, ln\, m(t) + \beta_5\, ln\, m(t-1) + \varepsilon \tag{11}$$

In this model, “Δ” represents the difference (or change), “y” denotes national income, “s” is the share of private sector savings in GDP, “g” stands for technological progress, “n” is the growth rate of the labor force, “d” represents capital depreciation, and “m” is the share of defense expenditures in GDP.

Dunne, Smith, and Willenbockel (2005) advocated the Extended Solow Model over the Feder–Ram model because it possesses several strengths. By incorporating both the current and lagged values of defense expenditures, the model gains a more dynamic structure, allowing for the testing of the lagged effects of defense spending. However, this approach introduces a multicollinearity problem. Moreover, while the Extended Solow Model retains some advantages, it loses the strong aspects of the Feder–Ram model by omitting non-defense government expenditures, thereby neglecting the externality effects of defense spending (Heo 2010).

Barro (1990) argued that policymakers could enhance long-run economic growth by adhering to public policies that do not rely on external factors. According to Barro (1990), an increase in public expenditures generates two distinct effects. Initially, the rise in public spending exerts pressure on the private sector, which might have a negative impact on growth. Subsequently, the increase in public expenditures leads to improvements in private sector productivity and consequently a rise in the growth rate. Barro (1990) also posited that there exists an optimal level of public expenditures, beyond which further increases would adversely affect growth. He further asserted that the optimal government size is achieved when marginal costs and marginal benefits are equal. The primary motivation behind Barro (1990)’s study was to identify the impact of externalities—such as public expenditures and taxes—on the private sector (Taşar 2015). Since the main source of financing for public expenditures is tax revenue, an increase in taxes adversely affects savings, thereby negatively impacting growth (Barro 1990).

Conversely, a reduction in tax rates is expected to support economic growth and stimulate private sector R&D activities (Erdoğan and Canbay 2016). Devarajan et al. (1996), using data from 43 countries covering the period from 1970 to

1990, modified the growth model developed by Barro (1990) to propose a new equation. This new model was argued to yield more robust estimates when compared with the Feder–Ram and Solow models, due to a series of theoretical and econometric issues present in the latter models (Dimitraki and Ali 2015). Barro (1990)'s growth model possesses several strengths relative to other models, as summarized by Yakovlev (2007):

1. It explicitly allows for the influence of various government expenditures financed by taxes on output through production.

2. It facilitates the measurement of efficiency and productivity in public expenditures and helps identify the distortionary effects of taxation.

3. It permits the investigation of nonlinear effects between public expenditures and economic growth.

4. Although numerous models exist regarding the effects of different components of government spending on economic growth and many of these econometric models are quite complex, Barro's (1990) model is comparatively simple and straightforward (Devarajan et al. 1996).

Due to these strengths, Yakovlev (2007) recommended the use of the Internal Barro model for determining the direction of the relationship between defense expenditures and economic growth. Assuming that the nexus between military expenditure and economic growth dynamics, the function ϕi = [ϕ1(η1), ϕ2] is defined as follows (D'Agostino et al. 2019):

$$\sum_{i=1}^{2} \emptyset\, i = 1 \Longrightarrow \emptyset 1(\eta 1) = 1 - \emptyset 2 \qquad (12)$$

Here, "ϕ1" represents the share of defense expenditures in GDP, and "η1" is the independent variable. The function ϕ1(η1) shows the effect of the defense expenditure component on the growth rate. The components of government expenditures depend on their relative shares ϕi and output elasticities. The partial derivative of γ with respect to ϕ1(η1) is given as follows:

$$\frac{\partial \gamma}{\partial \emptyset 1(\eta 1)} = \left(\frac{a}{\emptyset 1(\eta 1)} - \frac{\beta}{\emptyset 2}\right)\lambda \qquad (13)$$

In this expression, the sign of the partial derivative depends on the parameters within the brackets. For example, if the military spending component ϕ1 exhibits a positive partial derivative, it is classified as "productive" and is associated with a required level of output: $\frac{\partial \gamma}{\partial \emptyset 1(\eta 1)} \geq 0$

$$\frac{\emptyset 1(\eta 1)}{\emptyset 2} \leq \frac{a}{\beta} \qquad (14)$$

Conversely, if defense expenditures are deemed inefficient, then: $\frac{\partial \gamma}{\partial \emptyset 1(\eta 1)} \leq 0$

$$\frac{\emptyset 1(\eta 1)}{\emptyset 2} \geq \frac{a}{\beta} \qquad (15)$$

This formulation allows for the impact of an exogenous shock affecting one of the components to be captured (in this case, the share of defense expenditures in GDP will be analyzed). This study distinguishes itself by utilizing Barro's (1990) growth model alongside the ARDL (2001) and Bayer-Hanck (2013) tests, which have not been widely applied in this context. Earlier studies using the Feder-RAM and extended Solow models have been criticized for inadequately capturing the relationship between defense expenditure and economic growth (Dunne et al. 2005).

By employing a Barro (1990) type growth model, this study seeks to contribute to the literature. The study is organized into four sections. The introduction discusses the theoretical framework linking defense expenditure and economic growth. The second section reviews relevant literature and outlines empirical analyses of the relationship. The third section presents the analysis results, comparing them with findings from previous studies. Finally, solutions and suggestions for further studies were identified.

2. Literature

Research on the nexus between military expenditure and economic growth dates back to the early 1970s. One of the first significant empirical studies, conducted by Benoit (1978), found that defense expenditure positively influences economic growth. Since then, the topic has remained a subject of ongoing debate among scholars (Yang et al. 2011).

Several studies, including those by You and Looney, Frederick (1983), Lim (1983), and Fai, Annez, and Taylor (1984), have presented contrasting findings, suggesting that defense expenditure negatively affects economic growth. A common conclusion among these studies is that allocating national income to defense spending—rather than to public investments in education, healthcare, and infrastructure—can have adverse effects on economic growth (Gökbunar and Yalçınkaya, 2004).

The literature includes a broad range of empirical and theoretical studies on this relationship. Some studies support the Keynesian perspective, which argues that defense spending stimulates economic growth, while others favor the neoclassical view, which claims it impedes growth. Several studies, however, conclude that the impact is statistically insignificant. This study categorizes the literature into three groups for structured analysis.

The first group of studies, grounded in the Keynesian approach, posits that defense expenditure exerts a positive influence on economic growth. This perspective suggests that military spending generates positive externalities by fostering human and physical capital accumulation, infrastructure development, and R&D investments, thereby accelerating technological progress (Bekmez and Support, 2015). Among the most influential studies in this category, (Emile Benoit 1973; Emile Benoit 1978) conducted an analysis of 44 developing countries over the period 1950–1965 using a traditional growth model. His findings indicate that defense expenditure positively contributes to economic growth. Similarly, Atesoglu and Mueller (1990) employed the Feder-Ram model to assess the relationship between defense spending and economic growth in the United States from 1949 to 1989. Their results further corroborate the argument that defense expenditure exerts a positive and statistically significant influence on economic growth.

Sezgin (1997) examined the relationship between defense expenditure and economic growth in Türkiye from 1950 to 1993 using both supply-side and demand-side models within the Feder-Ram framework. His findings showed a favorable impact of defense spending on growth. A later study by Sezgin (2000) confirmed these results. Atesoglu (2002) used quarterly data for the U.S. from 1947:2 to 2000:2 and found that increased defense spending positively influenced economic growth using Johansen's VECM. Halıcıoğlu (2004) extended Atesoglu's model to Türkiye for 1950–2002 and similarly found a positive impact. Yıldırım, Sezgin, and Öcal (2005) examined 12 Middle Eastern countries, including Türkiye, using the Feder-Ram model and also found a positive relationship.

In contrast, Yılan and Özcan (2010) used Gregory-Hansen cointegration and Toda-Yamamoto causality analyses on Turkish data from 1950 to 2006. They found no long-term relationship, though a unidirectional causality ran from economic growth to defense expenditure. Yıldırım and Öcal (2016) evaluated 128 countries (2000–2010) and confirmed a favorable impact of defense spending on growth. Korkmaz (2019) segmented countries by religion, finding favorable impacts in Christian-majority countries, negative effects in Israel, and no significant effects in Muslim-majority countries. Naimoğlu and Uzbek (2022), using Fourier Shin and Shin cointegration tests, concluded that increased defense expenditure supports economic growth. Naimoğlu and Uzbek (2022) investigated the defense-growth nexus using Fourier Shin and Shin cointegration tests. Their analysis revealed that an increase in defense expenditure contributes to economic growth, suggesting a long-term positive relationship between military spending and economic performance..

The second group of studies, aligned with the neo-classical approach, contends that defense expenditure exerts an adverse effect on economic growth.. According to this perspective, military spending diverts scarce resources away from productive investments in key sectors such as education, healthcare, and technology, thereby hindering economic growth (Eyes 2016). You and Looney (1983) analyzed 44 developing countries from 1950 to 1965 using linear regression methods. Their findings suggest that while defense expenditure positively influences economic growth in high-income countries, it has a negative impact in low-income countries. Similarly, Lim (1983) examined 54 developing countries from 1965 to 1973 using the Harrod-Domar growth model and concluded that military spending negatively affects economic growth. Conversely, Fai, Annez, and Taylor (1984), using a demand-side model on 64 countries (1952–1970), found a negative effect. Galvin (2003) examined 64 developing countries, including Türkiye, and also reported a negative impact.

Lastly, Palaz and Karagöl (2004) applied Johansen cointegration and Granger causality analysis to Türkiye (1950–2002). Their findings further support the neo-classical view, demonstrating that defense expenditure adversely affects economic growth.. Aizenman and Glick (2006) conducted an empirical analysis examining the relationship between defense expenditure and economic growth in 92 countries, including Türkiye, over the period 1989–1998. Their findings suggest that the impact of military spending on economic growth is conditional on security threats. Specifically, during periods of low security threats, defense expenditure has a negative effect on economic growth, whereas in times of heightened security threats, it exerts a positive influence. Mylonidis (2008) investigated the economic implications of defense expenditure in 14 European countries by employing Barro's (1990) growth model. Utilizing both cross-sectional and panel data analysis for the period 1960–2000, the study found that defense expenditure negatively affects economic growth, supporting the neo-classical perspective. Similarly, Dunne and Nikolaidou (2012) analyzed the impact of military spending on 15 European Union countries using the Solow-Swan model. Their results indicate that defense expenditure has an adverse effect on economic growth, further reinforcing the argument that military spending crowds out productive investments.

Hou and Chen (2013), analyzing 35 developing countries (1975–2009) with GMM, confirmed the adverse effect. Shahbaz et al. (2013) found similar results for Pakistan using the ARDL method. Korkmaz (2015) applied panel data analysis to 10 Mediterranean countries and found a negative impact as well. Shahbaz et al. (2013) conducted an empirical analysis on Pakistan utilizing the ARDL method, concluding that defense expenditure exerts a significant negative effect on economic growth. Similarly, Korkmaz (2015) applied panel data analysis to a sample of 10 selected Mediterranean countries, finding that military spending negatively impacts economic growth. Lame (2018) used Bayer-Hanck and Maki cointegration tests on Türkiye (1960–2016) and found significant negative effects. Boztepe (2021), using the Smooth Transition Panel Regression Model in 14 Middle Eastern countries (2000–2019), reported that defense spending negatively affected economic growth in 11 countries, including Türkiye, though 4 countries showed a positive effect.

Furthermore, a range of studies conducted across different countries using various econometric methodologies—such as those by Canbay (2010), Kun (2010), Asiloğlu (2019), Canbay (2020), Torun et al. (2021), Dada et al. (2023), have consistently indicated that defense expenditure negatively affects economic growth. Beyond the two primary perspectives on the relationship between defense expenditure and economic growth, a third body of research focuses on whether a statistically significant association exists between the two variables. For instance, Kollias (1997) used Granger causality analysis in Türkiye and found no causal relationship.Similarly, Dritsakis (2004) investigated Türkiye and Greece using data from 1960 to 2001, finding a long-term cointegration relationship between defense spending and economic growth. However, short-term VECM causality analysis revealed a unidirectional causal link, with economic growth influencing defense expenditure in both countries. A broader review of the literature suggests that while defense expenditure can influence economic growth, there is no consensus regarding the direction or magnitude of this impact (Yeti et al. 2017; Halıcıoğlu 2004).

3. Data set and Variables

This study investigates the impact of defense expenditures on economic growth in Türkiye, with a particular focus on the direction of this relationship. The analysis utilizes annual data covering the period from 1990 to 2021. The key variables included in the study are the ratio of defense expenditures and gross fixed capital investments to gross domestic product (GDP), GDP per capita (real GDP based on 2015 fixed prices, in US dollars), total population, and human capital.

Following Barro (1991), who emphasized that high school education serves as a strong indicator of human capital due to its positive influence on economic growth, this study adopts the total number of individuals holding general and vocational high school diplomas as the human capital variable. Additionally, according to the Keynesian approach, population growth is expected to positively impact economic growth by stimulating effective demand (Telatar and Terzi, 2010). To account for this effect, total population is included as a control variable. The literature reveals a lack of consensus on both the impact of defense expenditures on economic growth and the most appropriate measure of defense spending—whether in monetary terms or as a proportion of GDP (Brauer 2002). Given this ambiguity, the study opts to use the ratio of defense expenditures to GDP to ensure a more standardized comparison across time

The data on the ratio of defense expenditures to GDP were obtained from the SIPRI database, while information on per capita GDP, total population, and the ratio of gross fixed capital formation to GDP was sourced from the World Bank databases. Additionally, data representing human capital were compiled from the book Statistical Indicators, 1923–2013, published by TÜİK (Turkish Statistical Institute), as well as other TÜİK statistical indicators. Table 1 presents an overview of the key variables included in the model, providing essential descriptive statistics and sources for each variable.

Table 1. Variables Used in the Analysis

Variables	Abbreviations	Data Source	Time Period
GDP per capita (real gross domestic product, in US dollars, based on constant 2015 prices)	PCI	World Bank	1990-2021
Defense expenditures % of GDP	DE	SIPRI	1990-2021
Total population	POPC	World Bank	1990-2021
Gross fixed capital investment as % of GDP	GFCF	World Bank	1990-2021
Human capital	HC	TSI	1990-2021

Note: "ln PCI" represents the per capita GDP (in constant 2015 prices/dollars); "lnDE" denotes the ratio of defense expenditures to GDP; "ln GFCF" represents the ratio of gross fixed capital formation to GDP; "ln POPC" indicates the total population; and "ln HC" stands for human capital.

4. Model

In this study, the Barro (1990)-type growth model, initially developed by Barro (1990) and later modified by Mylonidis (2008), was used to create the empirical model. The model used in the study is as follows:

$$ln(PCI) = \beta^0 + \beta^1 ln(DE_t) + \beta^2 ln(GFCF_t) + \beta^3 ln(POPC_t) + \beta^4 ln(HC_t) + \varepsilon_t \quad (16)$$

Upon examining Equation (16), the variables are defined as follows: "ln(PCI)" represents GDP per capita (2015 constant prices in US dollars), "ln(DE)" represents the ratio of defense expenditures to GDP, "ln(GFCF)" represents the ratio of gross fixed capital investments to GDP, "ln(POPC)" represents total population, and "ln(HC)" represents human capital. "β_0" is the constant term, "t" represents time, and "ε_t" refers to the error term.

The coefficients β_1, β_2, β_3, and β_4 represent the elasticities of defense expenditures, gross fixed capital investments, population, and human capital, respectively. The analysis was conducted by taking the natural logarithm (ln) of the variables in the model. Using the "ln" offers several important advantages, such as addressing issues related to the dynamic properties of the variables and interpreting the results as elasticity coefficients (Bhattacharya et al. 2016). Therefore, the logarithmic values of the series were used instead of their actual values in the study. Table 2 presents the descriptive statistics for the variables used in the model.

Table 2. Descriptive Statistics

Variables	Average	Median	Maximum	Minimum	Std. Dev	Number of Obs.
LPCI	8.96	8.95	9.49	8.56	0.29	32
LDE	-3.57	-3.64	-3.18	-4.10	0.28	32
LGFCF	3.22	3.24	3.39	2.88	0.13	32
LPOPC	18.04	18.05	18.25	17.81	0.13	32
LHC	12.49	13.03	14.28	10.37	1.12	32

When examining the information of the variables ln(PCI), ln(DE), ln(GFCF), ln(HC), and ln(POPC) in Table 3, it can be observed that ln(POPC) has the highest mean, median, maximum, and minimum values. In contrast, the variable ln(DE) exhibits the lowest mean, median, maximum, and minimum values. While the highest standard deviation value is associated with ln(HC), it can be seen that the variables ln(GFCF) and ln(POPC) have the lowest standard deviation values.

5. Methodology

This study's methodology is two-fold. First, stationarity of the variables is assessed using the Augmented Dickey-Fuller (ADF, 1981), Phillips-Perron (PP, 1988), and Zivot-Andrews (ZA, 1992) unit root tests. Second, ARDL (2001) and Bayer-Hanck (2013) cointegration tests are used to identify any long-term relationships between the variables.

The ADF (1981) and PP (1988) tests are based on the following hypotheses: $H_0: \delta = 0$ (The variable has a unit root), $H_1: \delta < 0$ (The variable does not have a unit root). Similarly, the basic hypothesis of the ZA (1992) test is: H_0: "There is a unit root" H_1: "There is no unit root" (Zivot and Andrews 1992).

ARDL and Bayer-Hanck cointegration tests help identify extended period relationships. The ARDL test is preferred due to its ability to work with I(0) or I(1) series, adaptability to small/large samples, and the advantages of the unrestricted error correction model (Narayan and Smyth, 2005). The ARDL bounds test involves three steps: (1) test for cointegration, (2) estimate extended period coefficients, and (3) estimate short-term elasticities (Pamuk and Bektaş, 2014).The unrestricted error correction model (ECM) created for the first stage of the ARDL approach is shown in Equation (17), which represents the version of the error correction model adapted to this study:

$$\Delta LPCI_t = a_0 + \sum_{i=t}^{m} \beta_{1i}\Delta LPCI_{t-i} + \sum_{i=t}^{m} \beta_{2i}\,\Delta LDE_{t-i} + \sum_{i=t}^{m} \beta_{3i}\,\Delta LPOPC_{t-i} + \sum_{i=t}^{m} \beta_{4i}\,\Delta LGFCF_{t-1} + \sum_{i=t}^{m} \beta_{5i}\,\Delta LHC_{t-i} + \beta_{6i}\,\Delta LPCI_{t-1} + \beta_{7i}\,\Delta LDE_{t-1} + \beta_{8i}\,\Delta LPOPC_{t-1} + \beta_{9i}\,\Delta LGFCF_{t-1} + \beta_{10i}\,\Delta LHC_{t-1} + u_t \quad (17)$$

In Equation (17), "Δ" indicates the first difference of the series, "u" represents the error term, and "m" indicates the lag length. Since the ARDL bounds test is based on the lag length of the variables, the appropriate lag length must be determined before performing the test (Pesaran et al. 2001). When selecting the lag length, two key points should be considered. The first is determining the lag length using the AIC, SIC, and HQ information criteria and selecting the value where the information criterion is the smallest. The second is ensuring there is no autocorrelation problem. If the selected lag length shows autocorrelation, the second smallest critical value should be chosen as the appropriate lag length. If autocorrelation persists, this process is continued until the problem is resolved (Koçak 2014; Karagöl et al. 2007).

In his study, Narayan (2004) highlighted that the F-test in the ARDL model has a non-standard distribution, especially when factors such as whether the model includes a constant or trend term, sample size, number of variables, and the stationarity levels of the variables are considered. The ARDL bounds test is performed to determine the existence of a significant long-term relationship between the variables. The F-statistic is calculated within the bounds test (Akel and Gazel 2014). The null and alternative hypotheses of the F-test are as follows (Narayan 2004):

"$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$ *(There is no cointegration relationship)*"

"$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$ *(There is a cointegration relationship)*"

The ARDL (Autoregressive Distributed Lag) approach employs two asymptotic critical bounds: I(0), representing the lower bound, and I(1), indicating the upper bound. When the computed F-statistic surpasses the I(1) threshold, the null hypothesis of no long-term relationship is rejected, signifying the existence of cointegration among the variables. Conversely, if the F-statistic falls below the I(0) bound, the null hypothesis is accepted, suggesting the absence of a long-run association. In cases where the F-statistic lies between these two bounds, the result remains inconclusive regarding the presence of a long-term relationship (Alper & Alper, 2017). Upon establishing cointegration, the analysis proceeds to the second phase, which entails estimating the long-run coefficients. The modified long-run ARDL model utilized in this study is detailed in Equation (18) (Narayan, 2004).

$$LPCI_t = a_0 + \sum_{i=1}^{m} \beta_{1i}\,LPCI_{t-i} + \sum_{i=1}^{m} \beta_{2i}\,LDE_{t-i} + \sum_{i=1}^{m} \beta_{3i}\,LPOPC_{t-i} + \sum_{i=1}^{m} \beta_{4i}LGFCF_{t-i} + \sum_{i=1}^{m} \beta_{5i}LHC_{t-i} + u_t \quad (18)$$

After obtaining the elasticity coefficients for the long-term relationship, tests for autocorrelation, heteroscedasticity, as well as CUSUM and CUSUMSQ tests are performed to verify the significance of the model (Akel and Gazel 2014). After ensuring that there are no issues with the model, the third stage of the ARDL analysis, the estimation of the conditional error correction model (ECM) that reveals short-term relationships, is conducted (Gülmez 2015). The adapted form of the conditional ECM that captures short-term relationships is shown in Equation (19) (Narayan 2004):

$$\Delta LPCI_t = a_0 + \sum_{i=t}^{m} \beta_{1i}\Delta LPCI_{t-i} + \sum_{i=t}^{m} \beta_{2i}\,\Delta LDE_{t-i} + \sum_{i=t}^{m} \beta_{3i}\,\Delta LPOPC_{t-i} + \sum_{i=t}^{m} \beta_{4i}\,\Delta LGFCF_{t-i} + \sum_{i=t}^{m} \beta_{5i}\,\Delta LHC_{t-i} + \beta_{6i}ECM_{t-1} + u_t \quad (19)$$

The Error Correction Model (ECM) coefficient indicates how much of the deviations from the short-term equilibrium will be corrected in the long term. The ECM coefficient must be between 0 and -1 and statistically significant (Alam and Quazi 2003). Bayer-Hanck (2013), recognizing the contradictory results of cointegration tests in the literature, developed a new approach by combining the Engle and Granger (1987), Johansen (1988), Boswijk (1994), and Banerjee et al. (1998) tests, along with a powerful test based on the Fisher (1932) chi-square distribution (Aktürk et al. 2014).

The statistics calculated for the Bayer-Hanck (2013) test are shown in the equation below. Equations (20), (21), and (22) express the probability values for the tests “PEG” (Engle and Granger 1987), “PJOH” (Johansen 1988), “PBO” (Boswijk 1994), and “PBDM” (Banerjee et al. 1998).

$$\chi_i^{-2} = -2\sum_{i\in I} \ln(pi) \quad (20)$$

$$EG - JOH = -2[ln(PEG) + ln(PJOG)] \quad (21)$$

$$EG - JOH - BO - BA = -2[ln(PEG) + ln(PJOH) + ln(PBO) + ln(PBDM)] \quad (22)$$

If the Fisher (1932) statistic exceeds critical values in the Bayer-Hanck (2013) table, the null hypothesis (no cointegration) is rejected in favor of the alternative (cointegration exists). The test requires all variables to be I(1) and a suitable lag length.

According to the results obtained from the cointegration bounds tests, if a cointegration relationship is found between the series, the next challenge is estimating the elasticity coefficients of the long-term series (Nazlıoğlu 2010). Using the OLS method to estimate long-term coefficients may lead to biased and inconsistent results.

To address this issue, Stock and Watson (1993) developed the DOLS method, which improves the estimation of long-term equilibrium. This method adds the independent variable’s own values, the lagged values of their differences, and the antecedent values to the model, thereby creating a more robust OLS estimator. The DOLS method has several advantages, which can be summarized as follows: It provides robust estimation results against non-homogeneous structures, small sample sizes, and issues such as autocorrelation and heteroscedasticity (Esteve and Requena 2006; Mark and Sul 2003). Moreover, it can be applied when the dependent variable is I(1) and the independent variables are either I(1) or I(0) (Çetin 2018). The DOLS equation is as follows:

$$y_t = x_t'\beta(+d_{1t}\psi_1 \sum_{i=q}^{r} \Delta x_{t+j}' \,\delta + u_{1t} \quad (23)$$

Here, “q” represents the optimal lag length, and “U_t” denotes the error term. After confirming the existence of cointegration between the variables in the long term, the DOLS was preferred for estimating the long-term coefficients due to the strengths mentioned above.

5. Analysis and Empirical Findings

In this part of the study, the outcomes of the econometric analyses are discussed. The analysis begins with an assessment of the stationarity properties of the variables. For this purpose, the study employs three unit root tests: the Augmented Dickey-Fuller (ADF, 1981), Phillips-Perron (PP, 1988), and Zivot-Andrews (ZA, 1992) tests. In all cases, the null hypothesis states that the variables possess a unit root, indicating non-stationarity, while the alternative hypothesis suggests that the variables are stationary. Table 3 displays the results obtained from the ADF and PP tests.

Table 3. ADF And PP Test Results

		ADF		PP	
	Variables	Fixed	Fixed and Trending	Fixed	Fixed and Trending
Level	LPCI	0.57	-2.40	1.94	-2.41
	LDE	-0.89	-2.05	-0.90	-2.19
	LGFCF	-1.99	-3.06	-2.00	-2.56
	LPOPC	-2.18	-2.03	-2.30	-1.62
	LHC	-1.44	-1.21	-1.36	-1.08
First Difference	LPCI	-5.50*	-4.27**	-6.10*	-6.92*
	LDE	-5.16*	-5.07*	-5.16*	-5.07*
	LGFCF	-5.97*	-5.86*	-5.99*	-5.88*
	LPOPC	-2.89***	-3.69***	-4.20*	-4.97*
	LHC	-6.33*	-6.48*	-6.34*	-6.56*

Note: *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively. While the lag length in the ADF unit root test was determined according to the Akaike Information Criterion (AIC), it was determined according to the

Newey-West bandwidth in the PP unit root test. The critical values for the ADF and PP tests are -3.66, -2.96, -2.61 for the fixed model, and -4.30, -3.57, -3.22 for the fixed and trend models at the 1%, 5%, and 10% significance levels, respectively.

As shown in Table 3, the ADF and PP tests indicate that LPCI, LDE, LGFCF, LPOPC, and LHC are non-stationary at their levels under both the constant and trend specifications but attain stationarity after first differencing. Table 4 presents the results from the Zivot and Andrews (1992) test.

Table 4. Zivot And Andrews Unit Root Test Results

		Model A		Model C	
		Break Point Time	Test Stats	Break Point Time	Test Stats
Level	LPCI	1999	-4.13	1999	-4.10
	LDE	2004	-3.83	2004	-3.65
	LGFCF	1998	-3.48	2004	-4.32
	LPOPC	2016	-2.72	2014	-3.53
	LHC	2004	-4.39	2013	-3.51
First Difference	LPCI	2003	-5.83*	2003	-5.79*
	LDE	2003	-5.45*	2003	-5.45**
	LGFCF	2003	-6.59*	2002	-6.66*
	LPOPC	2012	-4.82***	2012	-6.94*
	LHC	2003	-7.57*	2003	-7.82*

Note: All critical values are taken from Zivot and Andrews (1992): Model A: 1%, -5.34; 5%, -4.93; 10%, -4.58; Model C: 1%, -5.57; 5%, -5.08; 10%, -4.82. The maximum lag length was selected as 4. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4 displays the Zivot-Andrews (1992) test results, which account for a single structural break. These results similarly confirm that all variables remain non-stationary at level in both Model A and Model C, becoming stationary only after first differencing.

Since both the Bayer-Hanck (2013) and ARDL (2001) methods are highly sensitive to lag length selection, determining the correct lag length is crucial for obtaining reliable results (Pesaran et al., 2001). This process follows the unit root testing phase and must be completed prior to applying the models. In this study, the optimal lag length was determined to be 1, based on the Akaike Information Criterion (AIC). After selecting the lag length, the Breusch-Godfrey (B-G) test was employed to check for autocorrelation. The results revealed no evidence of autocorrelation. Table 5 summarizes both the lag length determination and the findings of the B-G test.

Table 5. The Delay Length And The B-G Test Results

Lag	AIC	B-g Test
0	-6.22	0.09
1	-15.65*	0.56

Note: * In the table, "lag" represents the lag length, and "AIC" represents the Akaike Information Criterion. The B-G test represents the Breusch-Godfrey Autocorrelation Test probability values.

In this study, after determining the lag length as 1, the ARDL bounds test was conducted to test for the existence of a long-term relationship between the variables. The results of the bounds test are presented in Table 6.

Table 6. ARDL Bounds Test Results

Model	k	N
F(LPCI, LDE ,LGFCF,LPOPC,LHC)	4	31
F statistic	lower bound I(0)	Upper bound I(1)
11.89*	4.09	5.53

Note: "K" represents the number of independent variables, and "N" represents the number of units. It shows significance at the 1% level. The critical values are taken from Table CI (V) in Pesaran et al. (2001:300).

The ARDL bounds test consists of three parts: lower bound, upper bound, and the instability region. If the calculated F statistic exceeds the upper bound, it is concluded that there is a cointegration relationship between the variables. If the F statistic does not exceed the lower bound, it indicates that there is no cointegration relationship.

However, if the F statistic falls between the lower and upper bounds, no conclusion can be drawn regarding the long-term relationship between the variables (Eriçok and Yılancı 2013). As shown in Table 6, the F statistic exceeds the upper bound, confirming cointegration. Subsequently, the Bayer-Hanck test is applied for robustness. Table 7 reports that Johansen (1988), Boswijk (1994), and Banerjee et al. (1998) show cointegration, while Engle-Granger (1987) does not. However, Bayer-Hanck Fisher statistics exceed critical values, confirming extended period cointegration.

Table 7. Bayer - Hanck (2013) Cointegration Test Results

Model: LPCI = f(LDE,LPOPC,LGFCF,LHC)				
	Engle-Granger (1987) test	Johansen (1988) Test	Boswijk (1994)Test	Banerjee et al. (1998) Test
The Test Statistic	-3.18	43.04 *	-3.737***	21.77**
Prob.	0.47	0.0030	0.0849	0.0286
Bayer and Hanck (2013) Cointegration Test				
	Fisher Statistics	Critical Values		
		%1	%5	%10
EG-JOH	13.108**	15.845	10.576	8.301
EG-JOH-BO-BDM	25.150 **	30.774	20.143	15.593

Note: The appropriate lag length was determined as 1 according to AIC. *, ** and *** indicate significance at 1%, 5% and 10% levels, respectively.

The evaluation of the results in Table 7 demonstrates that the Johansen (1988), Boswijk (1994), and Banerjee et al. (1998) tests all point to the presence of a cointegration relationship among the variables. On the other hand, the Engle and Granger (1987) test does not support such a finding. Nonetheless, the Bayer-Hanck (2013) combined cointegration test confirms the existence of long-term cointegration, as both of the calculated Fisher statistics exceed the 5% critical values listed in the Bayer-Hanck framework. This outcome leads to the rejection of the null hypothesis and acceptance of the alternative, thereby validating a stable long-term association between the variables. Following this confirmation, the study proceeds to estimate the long-run coefficients using both the DOLS and ARDL techniques. The results from the DOLS estimation are provided in Table 8.

Table 8. DOLS Long-Term Estimation Results

Variables	Coefficient	Standard Error	t-statistic	Probability Values
LPOPC	1.27*	0.16	7.73	0.0000
LDE	-0.37*	0.09	-3.79	0.0026
LGFCF	0.43*	0.05	8.65	0.0000
LHC	0.05*	0.01	5.37	0.0002
C	-17.51*	2.62	-6.61	0.0000
diagnostics by	R^2 =0.99, Adj-R^2 =0.99			

Note: The appropriate lag length was determined according to the AIC. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.

As shown in the results of the DOLS long-term estimator in Table 8, the coefficient of the defense expenditures (LDE) variable is negative and statistically significant, while the coefficients of the gross fixed capital investments (LGFCF), population (LPOPC), and human capital (LHC) variables are positive and statistically significant. When the long-term results are examined in detail, a 1% increase in defense expenditures leads to a 0.37% decrease in economic growth. A 1% increase in human capital and gross fixed capital investments results in an increase of approximately 0.05% and 0.43%, respectively, in Türkiye's economic growth. Finally, a 1% increase in population results in an average increase of 1.27% in economic growth. To test the long-term and short-term relationships, an ARDL model will be established between the series. First, the appropriate ARDL model will be selected based on the information criterion, and then the long-term and short-term error correction models will be estimated. In this study, the AIC criterion was used to determine the lag length. The most appropriate ARDL model for long-term estimation was selected to be (1,0,0,1,0). The results of the ARDL (1,0,0,1,0) long-term model are presented in Table 9.

Table 9. Long-Term ARDL (1,0,0,1,0) Model Estimation Results

Dependent Variable = LPCI				
Variables	Coefficient	Standard Error	t-statistic	Probability Values
LPOPC	1.63*	0.14	11.09	0.0000
LDE	-0.18***	0.10	-1.79	0.0853
LGFCF	0.49*	0.10	4.83	0.0001
LHC	0.03**	0.01	2.71	0.0122
C	-23.15*	2.32	-9.95	0.0000

Note: *, ** and *** respectively indicate 1% and 5% and 10% significance level.

As shown in Table 9, the long-term coefficients for human capital, population, and gross fixed capital formation are all positive and statistically significant. In contrast, the coefficient associated with defense spending is both negative and statistically significant. Specifically, a 1% rise in human capital, population, and gross fixed capital investment contributes to increases in economic growth by 0.03%, 1.25%, and 0.49%, respectively, over the long run. Conversely, a 1% rise in defense expenditures leads to a 0.18% reduction in long-term economic growth. The corresponding diagnostic test results are provided in Table 10.

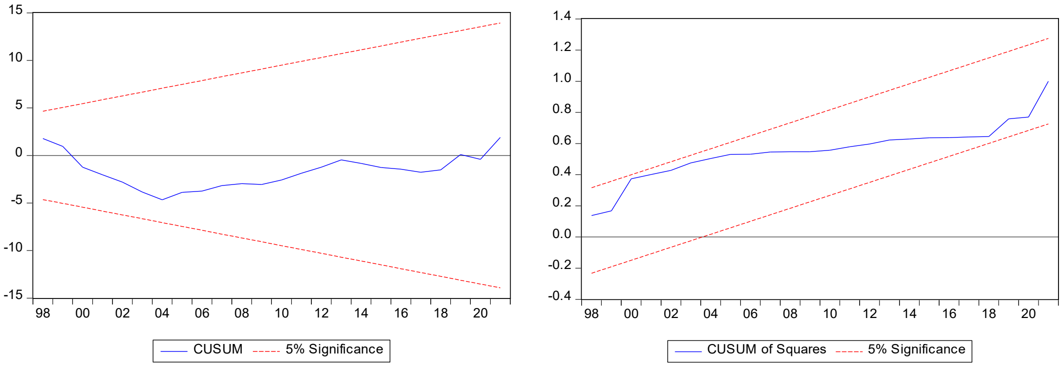
Table 10. Diagnostic Test Findings

Jarque-Bera Normality Test	3.02(0.21)
Ramsey reset test	0.75(0.45)
Changing Variance (Heteroskedasticity Test: Breusch-pagan-Godfrey	0.88(0.52)
Breusch-Godfrey LM test for Autocorrelation	1.25(0.30)

When the diagnostic test results presented in Table 10 are examined, it can be concluded that the errors in the established ARDL model are normally distributed, there is no model specification error, and no issues related to heteroscedasticity or autocorrelation are present.

The stability of the ARDL model was assessed by conducting the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests developed by Brown et al. (1975). The results of these tests are shown in Figure 1.

Figure 1. CUSUM and CUSUM of Square Tests



When examining the above graphs of the CUSUM and CUSUM squares tests for the period 1990–2021, the results indicate that the parameters of the ARDL model are stable over the analyzed period. In other words, no structural breaks were detected. After making long-term predictions, the short-term and ECM was adopted for estimation. The estimation results are summarized in Table 11.

Table 11. Short-Term ARDL (1,0,0,1,0) Model Results

Dependent Variable = LPCI				
Variables	Coefficient	Standard Error	t-statistic	Probability Values
D(LGFCF)	0.38*	0.38	10.08	0.0000
CointEq(-1)*	-0.51*	0.05	-9.28	0.0000

Note: *, ** and *** indicate respectively 1% and 5% and 10% significance level.

According to the findings in table 11, shows that the coefficient of the error correction term (ECMt−1) is −0.51, which is negative and statistically significant at the 1% level. This indicates a stable adjustment process toward the long-run equilibrium, with approximately 51% of any disequilibrium from the previous year being corrected each year. Furthermore, the empirical findings demonstrate that, in the short run, a 1% increase in gross fixed capital investment leads to a 0.38% expansion in economic growth.

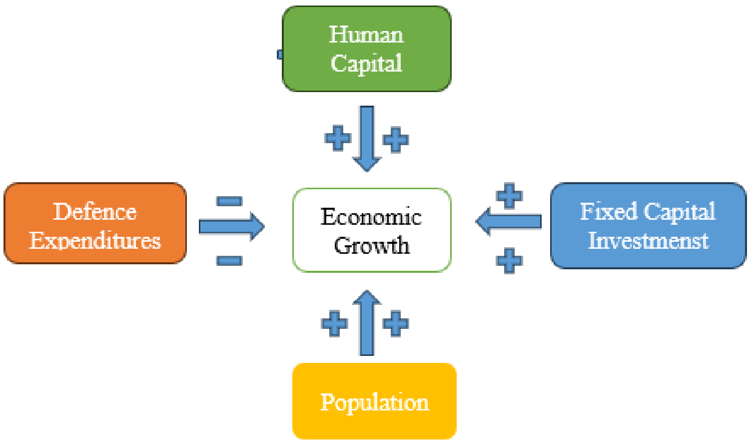
6. Results and Discussion

The theoretical and empirical literature on the relationship between defense expenditure and economic growth acknowledges that military spending influences economic performance; however, there is no consensus regarding the direction of this effect. The existing body of research is primarily shaped by two dominant theoretical perspectives: The Military Keynesian approach and the neo-classical approach. The Military Keynesian perspective posits that defense expenditure generates positive externalities, stimulating economic growth through increased aggregate demand, technological advancements, and infrastructure development. In contrast, the neo-classical approach argues that defense spending negatively affects economic growth by diverting scarce resources away from productive investments, such as education, health, and infrastructure, thereby crowding out more efficient economic activities.

This study investigates the impact of defense expenditure on economic growth in Türkiye over the period 1990–2021. The analysis is based on Barro’s (1990) growth model, with additional insights from Mylonidis (2008). The study incorporates key macroeconomic variables, including the share of defense expenditure and gross fixed capital formation in GDP, GDP per worker (measured in 2015 constant prices, USD), total population, and human capital. To examine the long-term relationship and estimate elasticity coefficients, the study employs the ARDL bounds testing approach (2001) and Bayer-Hanck cointegration test (2013). The ARDL model is further utilized to assess both long- and short-term dynamics, while the DOLS method ensures the robustness of the findings. Additionally, unit root tests (ADF, PP, and Zivot-Andrews) confirm that all variables become stationary at their first differences.

This study employs both the ARDL and Bayer-Hanck cointegration tests to establish the existence of a long-term relationship among the variables. After confirming cointegration, the long-run coefficients are calculated using the ARDL and DOLS estimation methods. The results indicate that military expenditure has a negative and statistically significant effect on economic growth, which is consistent with the theoretical expectations of the neoclassical framework. These results are consistent with prior empirical studies, including those conducted by Galvin (2003), Aizenman and Glick (2003; 2006), Palaz and Karagöl (2004), Canbay (2010), Kun (2010), Fear (2015), Lame (2018), Asiloğlu (2019),Altay ve Sugözü(2019), Canbay (2020), and Torun et al. (2021). A summary of these findings is presented in Figure 2.

Figure 2. Summary of Findings



Note: Created by the author.

According to the study findings, defense expenditure negatively affects economic growth, indicating that the neo-classical approach is valid for the analyzed period in Türkiye. In the long term, defense expenditure appears to have restrictive or exclusionary effects on investments in education, health, and similar areas. Given Türkiye's geopolitical and geographical position, maintaining a strong military is essential. Reducing defense expenditure could weaken the military, potentially threatening national independence, and integrity. To prevent such outcomes, the reasons for the negative impact of defense expenditure on growth must be identified, and these effects minimized.

The study indicates that the negative impact of defense expenditure on economic growth may stem from inefficiencies and ineffective resource allocation in Türkiye. However, further empirical research is required to substantiate this claim. To enhance the efficiency and effectiveness of defense spending, the defense budget should be formulated with transparency, adherence to international legal standards, and alignment with democratic principles. Additionally, military procurement processes—including those managed by defense institutions—should be subject to independent audits, ensuring accountability and freedom from political influence.

Based on the study's findings, the following policy recommendations are proposed to enhance the efficiency of defense expenditures and mitigate their negative impact on economic growth:

- Reducing reliance on arms imports by fostering the growth of the domestic defense industry through targeted investments and policy support.
- Developing specialized education programs at the vocational, undergraduate, and graduate levels to train a highly skilled workforce for the defense sector.
- Implementing tax incentives and ensuring access to affordable energy to stimulate domestic defense production while making necessary infrastructure investments to support industry growth.
- Establishing organized industrial zones specifically designed for defense-related manufacturing and research activities.
- Creating an independent regulatory and supervisory authority to oversee the defense sector, ensuring transparency, efficiency, and accountability in military procurement and resource allocation.

Future research on the nexus between military expenditure and economic growth should consider the influence of budget deficits, arms imports, external debt, balance of payments, energy consumption, carbon emissions, corruption, income distribution, and threat indicators to provide a more comprehensive analysis. Incorporating these factors would contribute to a more nuanced understanding of the economic implications of defense spending.

Moreover, a notable gap in the empirical literature is the lack of studies that integrate the Feder-Ram, Extended Solow, and Barro models. To enhance theoretical and empirical insights, researchers are encouraged to develop studies that combine these three models, utilizing time-series or panel data analysis. Such an approach could offer a more holistic perspective on the long-term effects of defense expenditure on economic growth.

Ethical Declaration

It is declared that scientific and ethical principles were adhered to during the execution and writing of this study, and that all sources used have been appropriately cited.

Declaration Regarding the Use of Artificial Intelligence

The authors commit to adhering to ethical principles, transparency, and responsibility in the use of artificial intelligence tools, ensuring their academic responsibility.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Article Submission and/or Revision: H. Kuzucu (+), O. Kızılkaya (+)

Note: The + and - symbols indicate whether authors contributed or did not contribute, respectively.

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