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Does Military Expenditure Hinder Economic Growth? Evidence from Major Countries of the World

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Abstract

This study endeavours to investigate the effect of military expenditure on economic growth in ten major countries of the world, which collectively contributed 75.2 per cent to global military expenditure in 2022. The period of study is 30 years, from 1992 to 2022, determined solely based on the availability of data. The selected major countries are the USA, China, Russia, India, Saudi Arabia, the UK, Germany, France, South Korea, and Japan. Employing a panel data model, this study estimated the Pooled Ordinary Least Squares Model, Fixed Effects Model (FEM) and Random Effects Model. After model estimation, model selection tests were applied, and it was found that the FEM is the appropriate one. However, when diagnostic tests were applied to the FEM, it revealed that the FEM suffers from the issues of cross-section dependence, heteroskedasticity and endogeneity. Therefore, FGLS, first difference GMM, and system GMM were used for the robustness, and the results identify military expenditure and gross capital formation as the most significant factors influencing economic growth. Military expenditure shows a negative effect, while gross capital formation shows a positive effect on economic growth. The reliability of the GMM estimators is confirmed by the Sargan and Hansen J-tests, indicating that the instruments used are valid. Additionally, the absence of second-order autocorrelation further supports the robustness of the GMM results. These findings offer a nuanced understanding of the underlying dynamics and suggest that countries worldwide should adopt peacekeeping policies, curtail military expenditures, and allocate scarce resources used in military operations to alternative sectors, which can ensure high economic growth worldwide.

Keywords: Military Expenditure, Economic Growth, FGLS, GMM, Growth Determinants
JEL Classifications: H56, C4, C51, O5

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1. Introduction

In the complex tapestry of global geopolitics and economic dynamics, the relationship between military expenditure and economic growth stands as a subject of perennial scrutiny and intrigue. As nations grapple with the challenges of security, defence, and economic prosperity, understanding the interplay between these two domains, military expenditure and economic growth, becomes imperative. Historically, nations have grappled with the delicate balance between maintaining a robust defence apparatus and fostering economic prosperity. The resources directed towards military endeavours not only impact a country's national security and geopolitical standing but also have ramifications for its overall economic health. Conversely, economic growth influences a nation's capacity to invest in defence, creating a reciprocal and dynamic relationship that necessitates a thorough investigation.

Military expenditure encompasses the financial resources earmarked by a nation for its military forces, defence infrastructure, procurement of defence equipment, and associated defence activities. This comprehensive spending umbrella covers various costs, ranging from personnel salaries and weapons procurement to the maintenance of military infrastructure, research and development, construction, operational expenses, and other outlays integral to national defence.

Crucially embedded within a country's budget, military expenditure varies significantly across nations due to various factors. Foremost among these factors are a nation's security priorities. Countries facing specific security concerns or threats are inclined to allocate a higher percentage of their budget to military expenditure. Additionally, a nation's strategic position on the global stage and its international alliances exerts considerable sway over its military budget. Economic strength and gross domestic product (GDP) also emerge as pivotal determinants, governing the extent to which a nation can afford to allocate resources for defence. Government policies and decisions wield a significant influence, as choices related to defence posture, modernisation efforts, and strategic considerations can mould the trajectory of military expenditure. The rapid evolution of military technology and the imperative to keep pace with emerging threats contribute to the dynamic nature of military expenditure. Furthermore, public sentiment and political pressures, particularly in democratic societies, are instrumental in shaping decisions related to military expenditure. The interplay of these diverse factors underscores the complexity of budgetary allocations for defence, reflecting the intricate web of considerations that nations navigate to safeguard their security interests.

The supporters of military expenditure argue that establishing defence industries locally can be economically advantageous. They liken weapons manufacturing to any other business, asserting that defence-related businesses generate employment and income similar to other industries. Military expenditure, acting as a stimulus to the economy, can enhance government expenditure, create demand and foster economic activity in defence-related sectors such as manufacturing, technology, and research and development. Military research and development activities have the potential to drive technological advancements with civilian applications, as demonstrated by innovations like the global positioning system (GPS), the internet, and various medical breakthroughs. Such technologies can permeate civilian sectors and benefit industries such as aerospace, communications, and healthcare, which may lead to the establishment of new manufacturing units and job opportunities, thereby positively affecting economic growth.

A robust defence industry supports domestic manufacturing and industrial sectors, often stimulating technological capabilities through the need for advanced machinery. Military expenditure generates employment not only for military personnel but also for civilians in defence-related industries, logistics, and support services. Military investments in infrastructure, such as airfields, ports, and roads, can enhance transportation and logistics networks, reducing costs and increasing efficiency for businesses. During times of war or geopolitical instability, increased military expenditure can stimulate economic activity in sectors involved in the production of military equipment and supplies. Military investments in education and training programmes benefit personnel and contribute to a more skilled workforce, with skills that translate into civilian sectors, further supporting economic growth.

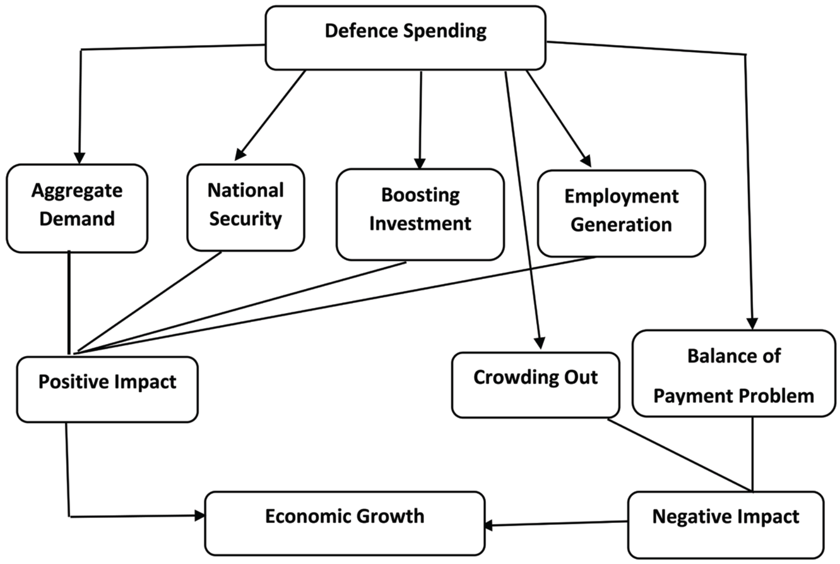
Adequate military expenditure plays a crucial role in maintaining economic stability, deterring external threats, and fostering a sense of security that encourages both domestic and foreign investment. By building military power, defence spending acts as a deterrent for potential aggressors, contributing to national security and minimising disruptions in trade and commerce. A fully integrated defence system can yield economic benefits, safeguard a nation's sovereignty, deter conflicts, and create a conducive environment for economic growth by attracting investments. Some countries with strong defence industries export military equipment and technology, contributing to trade surpluses and foreign exchange earnings, which can further support economic growth. However, it is essential to note that these positive effects of military expenditure are context-dependent and subject to the specific circumstances and economic policies of each country.

Positive effects notwithstanding, military expenditure also entails several negative implications that can adversely affect economic growth. Excessive allocation of financial resources to the military can impede economic development, particularly when such spending surpasses a nation's economic capacity or compromises investments in other critical sectors. The acquisition and maintenance of defence equipment, often reaching budgets in the billions of dollars, demand specialised personnel and incur substantial ongoing costs. Critics of military expenditure argue that the significant allocation of land, money, personnel, and resources to defence could be better utilised elsewhere, potentially fostering economic growth. Misallocation of resources is a concern when a substantial portion of a nation's budget is directed toward defence, leaving fewer resources for crucial investments in areas pivotal for long-term economic growth.

Figure 1 illustrates the channels through which defence spending influences economic outcomes.

As discussed, military spending can have both positive and negative effects on economic growth. On the positive side, defence spending increases aggregate demand, enhances national security, boosts investment, and generates employment, all of which contribute to economic growth. However, it can also have negative consequences, such as crowding out private sector investment and creating balance of payment problems, which may impede economic growth. The overall impact of defence spending on economic growth depends on the balance between these positive and negative effects.

Figure 1: Channels of Military Expenditure Effecting Economic Growth



Source: Mohanty et al. (2020)

Military expenditure represents an opportunity cost, diverting funds from potentially more productive uses that directly contribute to economic growth, such as education, healthcare, infrastructure, skills development, innovation, or other civilian sectors. High military spending can lead to increased government borrowing, potentially resulting in higher interest rates and diminished private-sector investment. The "crowding out" effect emerges when government resources and investments in civilian sectors are eclipsed by defence spending, limiting private enterprise and entrepreneurship and impeding economic growth. A disproportionate focus on military expenditure may skew national priorities, creating an imbalanced economy that hinders overall economic growth. Budget deficits and increased government debt can result from high military spending, potentially leading to unsustainable debt levels with detrimental long-term effects on economic growth. Concerns about economic stability and the possibility of higher taxes to fund defence can erode consumer and business confidence in countries with excessive military expenditure, further hindering economic growth. Inefficiency and corruption present additional challenges, as a significant portion of military expenditure may be lost to these issues, reducing resources available for productive economic activities.

Hence, the effect of military expenditure is dual-fold. On the one hand, it yields positive externalities by contributing to infrastructure development, human capital enhancement, technological progress, national defence, and demand stimulation. On the other hand, military expenditure can adversely affect economic growth by crowding out private investment, diverting public resources to less productive areas, and instigating domestic and international conflicts. The net effect of these diverse forces remains theoretically uncertain and empirically inconclusive. Consequently, a re-evaluation of the effect of military expenditure on economic growth, focusing on major countries of the world, becomes imperative.

The motivation behind this study stems from the ongoing debate about the economic effects of rising military expenditure. Despite extensive research on the topic, there is still no clear consensus on how military expenditure affects economic growth. Some argue that high military expenditure boosts economic activity through technological innovation, infrastructure development, and job creation, while others suggest that it diverts resources away from productive sectors, ultimately hindering growth.

This study aims to reconcile the conflicting perspectives on the relationship between military expenditure and economic growth by focusing on ten of the world's largest military spenders, which collectively accounted for 75.2 per cent of global military expenditure in 2022. The analysis uses data spanning from 1992 to 2022 to assess the effect of military expenditure on economic growth while accounting for five control variables such as trade openness, inflation, foreign direct investment, gross capital formation and population growth rate.

The methodology involves panel data estimation, beginning with Pooled Ordinary Least Squares (OLS) Model, and further employing both Fixed Effects Model (FEM) and Random Effects Model (REM) to identify the most suitable approach. To ensure robustness and validate the findings, the study additionally applies Feasible Generalized Least Squares (FGLS) and Generalized Method of Moments (GMM) models.

The findings offer important insights, while foreign direct investment, capital formation, and population positively influence economic growth, but inflation negatively affects it. Military expenditure is found to have a negative and statistically significant impact on economic growth. This study contributes to the existing literature by providing an updated and global perspective on the relationship between military spending and economic growth. It emphasises the need for a policy shift towards peaceful international relations and reduced defence budgets, which could potentially support more productive alternative purposes necessary for sustainable economic development.

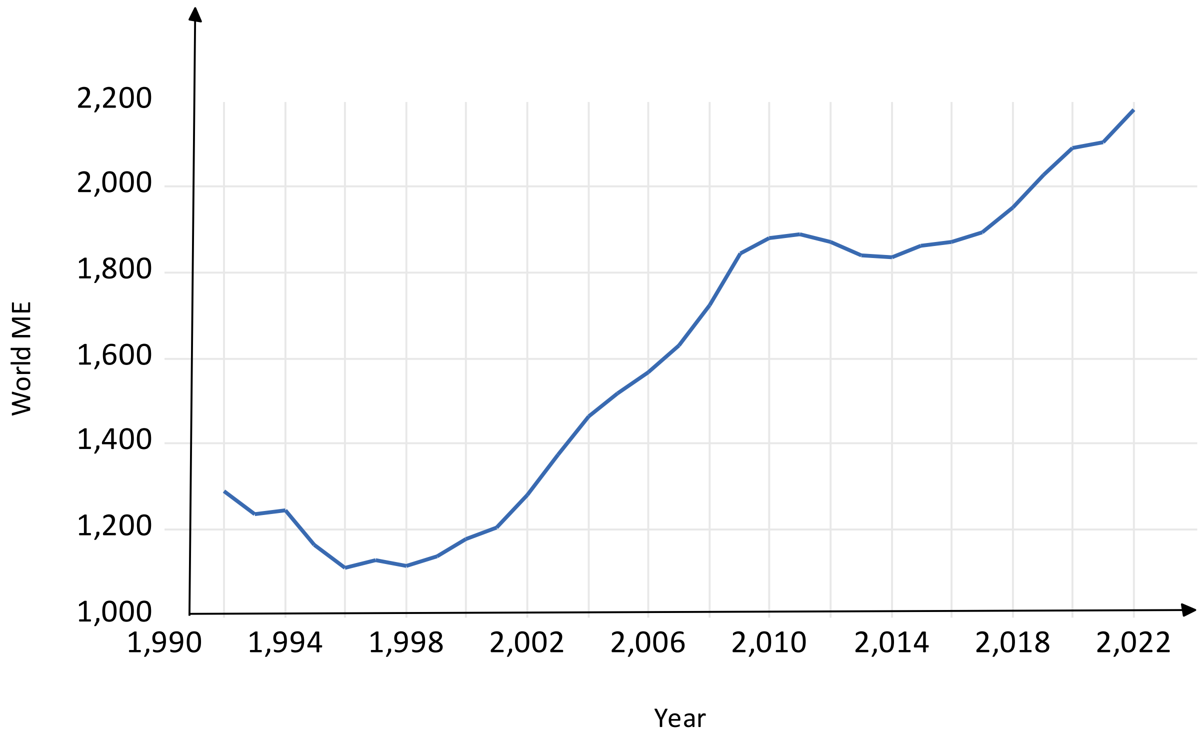
2. Global Trend of Military Expenditure

As we embark on an exploration of the effect of military expenditure on economic growth, a crucial starting point is an understanding of the prevailing trend in global military expenditure. The allocation of financial resources to defence initiatives has evolved significantly in recent years, shaping geopolitical landscapes and influencing economic trajectories. In this context, exploring the patterns and changes in military expenditure becomes crucial, offering a comprehensive foundation for our examination of the influence of military expenditure on economic growth.

The Stockholm International Peace Research Institute (SIPRI), an independent international organisation based in Sweden, meticulously monitors and publishes data on military expenditure. The SIPRI Military Expenditure Database provides comprehensive information on the annual military expenditure of countries, spanning as far back as 1949. Figure 2 illustrates the trend of world military expenditure over the last three decades.

As depicted in Figure 2, global military expenditure has exhibited an upward trajectory over the past three decades. It surged from US$ 1287.9 billion in 1992 to US$ 2181.91 billion in 2022, representing approximately 2.2 per cent of the global GDP in 2022. Global military expenditure trends are influenced by international efforts and arms control agreements. Agreements like the New START Treaty between the United States and Russia, designed to reduce nuclear weapons, have the potential to impact military budgets. Countries may adjust their defence priorities over time, directing investments towards different capabilities, such as cyber warfare, space, or emerging technologies, thereby influencing the allocation of defence budgets.

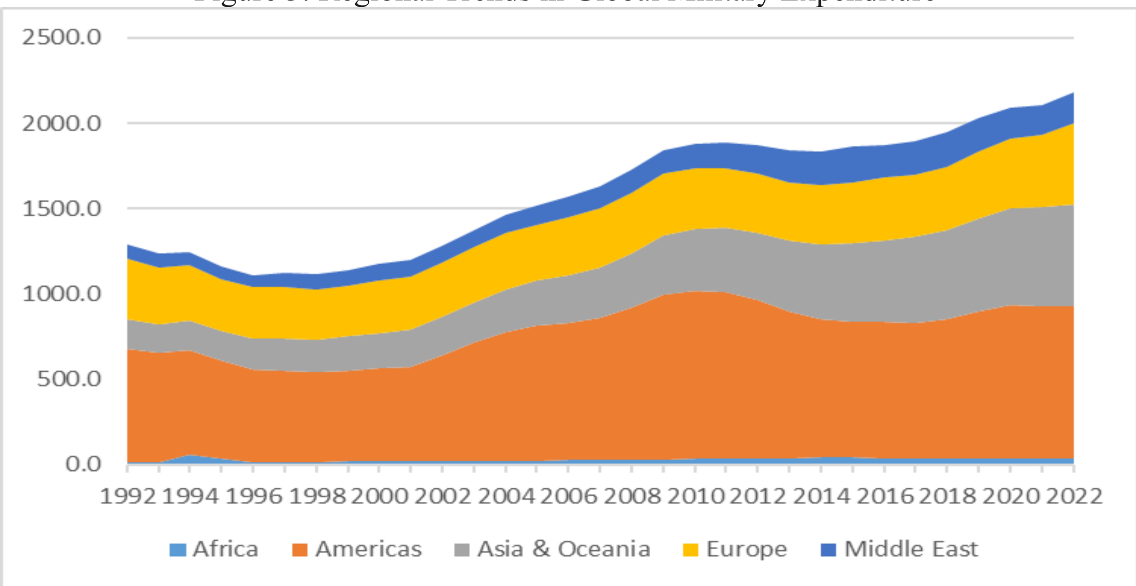
Figure 2: Trend of World Military Expenditure (in US$ Billion)



Source: Prepared by authors.

Patterns of military expenditure exhibit substantial variations across regions. Figure 3 presents regional military expenditure data from 1992 to 2022.

Figure 3: Regional Trends in Global Military Expenditure



Source: Prepared by authors.

As clear from Figure 3, the Americas had the highest military expenditure during the period from 1992 to 2022, albeit the share of the Americas in world military expenditure declined consistently from 52 per cent in 1992 to 41 per cent in 2022. However, the share of Africa in world military expenditure remained the lowest, and it never touched the figure of 5 per cent. The share of Asia and Oceania has a rising trend during the same period. Its share in world military expenditure doubled from about 13 per cent in 1992 to 27.3 per cent in 2022. Conversely, the share of Europe reduced from 27.7 per cent in 1992 to 22 per cent in 2022. The Middle East witnessed fluctuations in its share, and it remained between 6 and 11 per cent.

The comprehensive overview of military expenditure across the 10 major countries underscores the significant role these countries play in shaping global military allocations. The selected countries, representing economic powerhouses, collectively contributed a substantial 75.2 per cent to the world's military expenditure in 2022. Table 1 provides a comparative overview of the contributions of these countries to global military expenditure in 2022.

Table 1: Military Expenditure of Ten Major Countries

Country	Military Expenditure (US$ Billion)	Military Expenditure (% of GDP)	Military Expenditure (% of general government expenditure)	Share in World Military Expenditure (%)
USA	877	3.49	8.32	39
China	292	1.60	4.79	13
Russia	86.4	4.06	10.35	3.9
India	81.4	2.43	8.26	3.6
S. Arabia	75.0	7.42	20.52	3.3
UK	68.5	2.23	5.29	3.1
Germany	55.8	1.39	2.75	2.5
France	53.6	1.94	3.43	2.4
S. Korea	46.4	2.71	10.57	2.1
Japan	46.0	1.08	2.53	2.1

Source: World Development Indicator, World Bank database (2022).

The staggering dominance of the United States is evident from Table 1, accounting for 39 per cent of global military expenditure. China has notably increased its military expenditure, securing its status as the second-largest spender globally. Furthermore, the combined military expenditures of the United States and China alone represent over half, highlighting their pivotal influence on global military expenditure. Russia emerges as the third-largest contributor, solidifying its strategic position in the realm of military expenditure. Other major countries include India, Saudi Arabia, the UK, Germany, France, South Korea, and Japan. As we delve into the interconnections between military expenditure and economic growth, this data provides a foundational understanding of the major players shaping the international landscape, setting the stage for a nuanced exploration of their economic implications.

The subsequent sections of this paper unfold as follows: Section 3 presents a selected review of literature. Section 4 outlines the model and methodology employed in this study. Following that, Section 5 presents the results and initiates the discussion. Ultimately, Section 6 encapsulates the conclusion.

3. Review of Literature

Some of the research papers considered in this study delve into the relationship between military expenditure and economic growth across various groups of countries or individual countries, predominantly employing panel data or time-series data analyses. These studies yield mixed results, with some showing a positive impact while others indicate a negative effect of military expenditure on economic growth. Table A.1 given in the appendix provides a summary of the reviewed studies showing a positive effect of military expenditure on economic growth, while Table A.2 given in the appendix provides a summary of the reviewed studies showing a negative effect of military expenditure on economic growth.

The earliest studies supporting the positive impact of military expenditure on economic growth include Benoit (1978). He challenged conventional wisdom by revealing a positive relationship between higher military expenditure and accelerated economic growth in developing countries from 1950 to 1965. The study emphasised the importance of defence programme composition, suggesting that tailored programmes focusing on civilian-utilisable training could enhance civilian sector productivity. These findings highlight a complex relationship between military expenditure and economic growth, challenging the traditional view that military expenditure hampers economic growth in developing countries.

Landau's (1994) study investigated the relationship between military expenditure and economic growth in large less developed countries. Using regression analysis, the study examines the impact of military expenditure, squared military expenditure, and non-military expenditure on economic growth. The findings suggest a non-linear relationship between military expenditure and economic growth, varying across different geographic regions. The study highlights the importance of managing military expenditure to promote long-term economic development in less developed countries. In another study, Landau (1996) analysed the impact of military expenditure on economic growth in 17 wealthy OECD countries from 1950 to 1990. The study finds that military expenditure has a non-linear effect on economic growth, characterised by an inverted U-shaped relationship. At lower levels of military expenditure, increased spending is associated with faster economic growth, attributed to heightened vigilance against rent-seeking and inefficient policies during times of threat. However, beyond a threshold of approximately 5 per cent of GNP, further increases in military expenditure slow down economic growth due to resource misallocation. The findings are robust across different model specifications, though they exclude outliers like Japan, Austria, and Finland due to their unique constraints on military spending.

Yildirim et al. (2005) investigated the relationship between military expenditure and economic growth in the Middle East and Turkey from 1989 to 1999. Using panel estimation techniques, they found a positive impact of military expenditure on economic growth. Their study used dynamic panel data analysis, including the FEM and the GMM technique. Data was collected from SIPRI Yearbooks and World Bank Economic Indicators. The results showed a statistically significant positive effect of military expenditure on economic growth, particularly in low- and middle-income countries. The study suggested that the defence sector might be more productive than the civilian sector in these regions.

Kollias et al. (2007) analysed the connection between military expenditure and economic growth in 15 European Union (EU) member countries using panel data from 1961 to 2000. They found a positive relationship between military expenditure and economic growth, suggesting that military expenditure can stimulate demand and technical progress, particularly in technologically advanced countries. Their study used dynamic panel data analysis, revealing insights into how military expenditure impacts economic performance in the EU.

Pradhan's (2010) study explored the relationship between military expenditure and economic growth in India, China, Nepal, and Pakistan from 1988 to 2007. The study used Johansen's cointegration and panel Granger causality tests and found unidirectional causality from military expenditure to economic growth in Nepal and China. Pan et al. (2015) investigated the causal relationship between military expenditure and economic growth in 10 Middle Eastern countries over the period 1988 - 2010. They used variables such as per capita real GDP, per capita real military expenditure, and per capita real capital stock. Employing a panel causality approach, the study found one-way Granger causality from military expenditure to economic growth in Turkey and feedback between military expenditure and economic growth in Israel. In Egypt, Kuwait, Lebanon, and Syria, causality ran from economic growth to military expenditure, while no causality was observed in Bahrain, Jordan, Oman, and Saudi Arabia.

Shahid & Saba (2015) analysed the relationship between military expenditure and economic growth across 56 countries using panel data from 1995 to 2011. They employed the FEM and found a positive but relatively modest effect of military expenditure on economic growth compared to other forms of government spending. The study suggested that redirecting resources from the military to areas like infrastructure, education, or healthcare could lead to more significant economic benefits. Additionally, it highlighted that military expenditure might dampen private investment and recommended alternative allocations for more effective economic growth. Adbel-Khalek et al. (2019) explored the relationship between military expenditure and economic growth in India from 1980 to 2016 using Hendry's General-to-Specific (GTS) modelling. They found no direct causal link between military expenditure and economic growth during this period. However, they highlighted India's military industry's role in fostering technological spillover to civilian sectors and indirectly contributing to economic growth. The study emphasised the importance of peace initiatives and alternative government expenditure, such as infrastructure investment for sustainable economic growth in India.

Dimitraki & Win (2021) investigated the relationship between military expenditure and economic growth in Jordan from 1970 to 2015. Employing the Gregory-Hansen (GH) cointegration technique and the Autoregressive Distributed Lag (ARDL) approach, the study found a long-run relationship between military expenditure and economic growth and a positive effect of military expenditure on economic growth in both the short- and long-run. Mohanty et al. (2020) analysed the effect of military expenditure on economic growth in India for the period from 1970–1971 to 2015–2016 using the ARDL model and Toda-Yamamoto Granger causality approach. The study found that military expenditure, particularly capital military expenditure positively affected economic growth in India in both the short- and long-run. The study suggested restructuring military expenditure to prioritise capital military expenditure to further enhance economic growth in India.

In addition to the above studies, there are some studies that found negative impact of military expenditure on economic growth. Chang et al. (2001) analysed the relationship between military expenditure and economic growth in Taiwan and mainland China from 1952 to 1995. The study used cointegration analysis, Vector Autoregressive Model (VAR), and Granger-causality tests and found bidirectional Granger causality between military expenditure and economic growth for Taiwan, while unidirectional causality was observed from economic growth to military expenditure for mainland China. The study revealed no arms race between the two regions and identified the correlation between tension across the Taiwan Strait and Taiwan's military spending. Tiwari & Tiwari (2010) examined the relationship between military expenditure and economic growth in India using Vector Error Correction Model (VECM) analysis and Granger causality tests. They found bidirectional causality between GDP and military expenditure, and unidirectional causality was observed from GDP and gross domestic savings to merchandise trade. However, military expenditure was not found to Granger cause gross domestic savings. Impulse Response Functions (IRF) analysis revealed that an increase in military expenditure in India might lead to increased openness and domestic savings but could negatively impact GDP.

Chang et al. (2011) investigated the relationship between military expenditure and economic growth of 90 countries across income groups and regions using Dynamic Panel Data (DPD) analysis, taking data from 1992 to 2006. The study found a negative impact of military expenditure on economic growth in low-income countries, Europe, and the Middle East–South Asia regions. The study suggested that developing countries may benefit more from focusing on economic growth rather than increasing military expenditure. Wijeweera & Webb (2011) investigated the relationship between military expenditure and economic growth in five South Asian countries - India, Pakistan, Nepal, Sri Lanka, and Bangladesh - from 1988 to 2007. They conducted panel unit root tests, co-integration tests, and Granger causality tests and estimated FEM. The study found that a 1 per cent increase in military expenditure resulted in only a 0.04 per cent increase in real GDP, indicating a negligible impact on economic growth.

Hou & Chen (2012) analysed the impact of military expenditure on economic growth across 35 developing countries, taking data from 1975 to 2009. They used the Augmented Solow Growth Model and various empirical estimators such as OLS, FEM, FGLS, first-differences GMM estimator, and the system GMM estimator. Their findings showed a significant negative effect of military expenditure on economic growth. Dunne & Tian (2016) investigated the impact of military expenditure on the economic growth of 97 countries from 1960 to 2014 using an augmented Solow growth model. They consistently found a negative effect of military expenditure on economic growth across different time periods and country subgroups. The study concluded that military expenditure diverts resources from more productive government activities, leading to significant opportunity costs and impeding overall economic performance.

Kunu et al. (2016) analysed the relationship between military expenditure and economic growth across twelve Middle Eastern countries from 1998 to 2012 using panel data analysis. Employing the REM, they found that military expenditure had a negative impact on economic growth. The global financial crisis of 2009 exacerbated the negative effect of military expenditure on economic growth, especially during periods of internal and external conflicts. The study concluded that military expenditure detrimentally affects economic growth in Middle Eastern countries, particularly during times of conflict.

Mangir & Kabaklarli (2016) conducted a panel data study spanning 23 years from 1991 to 2013 to examine the relationship between military expenditure and economic growth in developed and developing countries. Authors used the FEM to address individual and time effects, and diagnostic tests were conducted to address potential issues like autocorrelation and heteroskedasticity. Their findings showed that military expenditure had a negative but statistically insignificant impact on economic growth, but government expenditure and gross capital formation had a positive and significant impact, aligning with Keynesian economic theory. The study advocated for reallocating economic resources towards efficient long-term investments and endorsed peaceful policies to foster economic growth, in line with the Barro growth theory. Cevik & Ricco (2018) investigated the relationship between military expenditure and economic growth across advanced and developing countries from 1984 to 2014. Using a DPM and the system GMM estimator to address potential endogeneity issues and country-specific effects, the study showed no significant positive effect of military expenditure on economic growth. Additionally, the type and level of security threats didn't alter this relationship. The study suggested that while well-designed military expenditure could contribute to growth, excessive allocations might impede economic growth by diverting resources from more productive areas.

After thoroughly reviewing studies in the field concerning the relationship between military expenditure and economic growth in various countries, conducted by different researchers, conflicting results have been observed. As mentioned earlier, some studies show a positive impact of military expenditure on economic growth, while others indicate the traditional approach suggesting a negative effect, positing that military expenditure impedes a country's economic growth.

Despite numerous global studies exploring this relationship, there appears to be a lack of research focusing on countries that contribute a substantial share of the world's military expenditure. This study aims to address this gap by undertaking a comprehensive study that predominantly focuses on countries making a significant contribution to the total global military expenditure. The top 10 countries in worldwide military expenditure form the basis for this study. The research aims to analyse the effect of military expenditure on economic growth using a panel data model.

4. Model and Methodology

In this study, the dependent variable is the growth rate of GDP (measured in constant 2015 US dollars), and it serves as an indicator of economic growth, as used in previous studies (Dimitraki & Win, 2021; Chang et al., 2011; Wijeweera & Webb, 2011; Kunu et al., 2016). The key independent variable is military expenditure, expressed as a percentage of GDP. This variable has been widely explored in numerous studies (Landau, 1994,1996; Kollias et al., 2007; Pradhan, 2010; Pan et al., 2015; Shahid & Saba, 2015; Abdel-Khalek et al., 2019; Dimitraki & Win, 2021; Chang et al., 2001; Tiwari & Tiwari, 2010; Chang et al., 2011; Wijeweera & Webb, 2011; Hou & Chen, 2012; Dunne & Tian, 2016; Kunu et al., 2016; Mangir & Kabaklarli, 2016; Cevik & Ricco, 2017).

The analysis also includes five control variables, such as trade openness, inflation, foreign direct investment, gross capital formation and population growth rate. Trade openness is measured as the sum of exports and imports as a percentage of GDP, following the methodologies of Landau (1994), Mohanty et al. (2020), and Tiwari & Tiwari (2010). Inflation is represented by the inflation rate based on the GDP deflator. Foreign direct investment is defined as net inflows of foreign direct investment as a percentage of GDP. Gross capital formation refers to gross capital formation as a percentage of GDP, supported by studies such as Yildirim et al. (2005) and Shahid & Saba (2015). Lastly, the population growth rate is included as a control variable, as examined in the works of Chang et al. (2011), Hou & Chen (2012), Dunne & Tian (2016), Kunu et al. (2016), and Dimitraki & Win (2021).

Data sourced from the World Bank's World Development Indicators. The study focuses on the top 10 countries worldwide that allocated the highest amount to military expenditure in 2022. These countries are the USA, China, India, the UK, Russia, France, Germany, Saudi Arabia, Japan, and South Korea. The study covers the time period of 30 years from 1992 to 2022, based on the availability of data.

The panel data model used to examine the effect of military expenditure on economic growth is outlined as follows:

$$GRGDP_{it} = \alpha + \beta_1 ME_{it} + \beta_2 TOPEN_{it} + \beta_3 INFLATION_{it} + \beta_4 FDINI_{it} + \beta_5 GCFR_{it} + \beta_6 PGR_{it} + \varepsilon_{it} \quad (1)$$

$$i = 1, 2, \ldots, 10$$
$$t = 1, 2, \ldots, 31$$

Where the dependent variable (GRGDP), representing the growth rate of GDP at constant US$ 2015, is the indicator of economic growth. The independent variable (ME) shows military expenditure as a percentage of GDP, and the control variables are:

TOPEN stands for trade openness, measured as total trade (the sum of exports and imports as a percentage of GDP); INFLATION denotes the inflation rate (based on GDP deflator); FDINI represents a foreign direct investment net inflow (as a percentage of GDP); GCFR signifies gross capital formation (as a percentage of GDP); and PGR represents the population growth rate.

The null and alternate hypotheses taken in this study are as follows:

H_0: Military expenditure has no significant effect on economic growth.
H_1: Military expenditure has a significant effect on economic growth.

These hypotheses will help determine whether military spending influences economic growth in the selected countries.

The methodology of this study involves model estimation and diagnostic testing using various conventional and modern panel data methods, including Pooled OLS, FEM, and REM. This approach is consistent with previous research in the field, such as the studies by Yildirim et al. (2005); Kollias et al. (2007); Landau (1994); Shahid & Saba (2015); Hou & Chen (2012); Kunu et al. (2016); Mangir & Kabaklarli (2016); and Cevik & Ricco (2017). These studies have similarly employed panel data techniques to analyse various economic relationships, providing a robust methodological foundation for this analysis.

Subsequently, model selection and diagnostic tests were conducted. To decide between Pooled OLS and FEM, an F test was employed, with the null hypothesis asserting the validity of the Pooled OLS model. Rejection of this hypothesis indicates the appropriateness of FEM, while non-rejection implies the validity of the Pooled OLS model. The choice between Pooled OLS and REM was determined using the Breusch and Pagan Lagrange Multiplier Test. The null hypothesis, stating no panel effect, was tested, and rejection favoured the REM, while non-rejection indicated the validity of Pooled OLS. The selection between FEM and REM involved the Hausman test, where the null hypothesis posited the consistency of the REM. Rejecting this hypothesis favoured FEM, while non-rejection favoured REM. Once the suitable model was identified, diagnostic tests were conducted to assess issues such as cross-sectional dependence (CDS), heteroskedasticity, endogeneity, and autocorrelation.

Tests for CSD included the Breusch-Pagan LM test and the Pesaran CSD test, both examining correlation among residuals across entities. Tests for heteroskedasticity comprised the Modified Wald test for groupwise heteroskedasticity, while autocorrelation was assessed using the Woolridge test for autocorrelation in panel data. Due to the presence of issues such as CSD, endogeneity, and heteroskedasticity in the selected model, alternative estimation methods were employed to ensure the robustness of the results. These methods include the FGLS model, as proposed by Parks (1967), the first-difference GMM introduced by Arellano & Bond (1991), and the system GMM estimator suggested by Arellano & Bover (1995). This approach aligns with previous studies that have addressed similar econometric challenges, such as Yildirim et al. (2005); Chang et al. (2011); Hou & Chen (2012); and Cevik & Ricco (2017). These methods ensure efficiency and consistency by accommodating CSD, endogeneity, heteroskedasticity across panels, and autocorrelation in the estimation process.

The first difference GMM was introduced to the growth literature by Caselli et al. (1996). In this approach, the dynamic growth regression equation is first transformed into first differences to eliminate unobserved country-specific effects. In the first-differenced equation, lagged levels of the series, specifically those lagged two periods or more, are used as instruments for the right-hand side variables. Yaffee (2003) suggested that, in the presence of heteroscedasticity, autocorrelation, and endogeneity, first-difference GMM estimation with robust panel standard errors (such as White and Newey-West) is a reliable estimator. However, Blundell & Bond (1998, 2000) and Bond et al. (2001) demonstrated that when time series are persistent or close to random walks, the lagged values of the variables become weak instruments, as they are only weakly correlated with the endogenous variables.

Moreover, first-difference GMM suffers from a loss of valuable observations, leading to poor performance and suboptimal finite sample properties, including bias and imprecision. In such cases, the system GMM estimator, proposed by Arellano & Bover (1995) and further developed by Blundell & Bond (1998), is a more effective alternative. The system GMM combines two sets of equations: the standard first-differenced equations and an additional set of level equations. The first set uses lagged levels as instruments for the differenced variables, as in the first-difference GMM, while the second set employs lagged first differences as instruments for the level equations. Blundell & Bond (1998) show that the system GMM provides consistent and efficient parameter estimates, with superior asymptotic and finite sample properties compared to the basic first-difference GMM estimator.

To validate the instruments used in the GMM estimation, specification tests suggested by Arellano & Bover (1995) are applied. First, the Arellano–Bond test is used to check for second-order serial correlation in the first-differenced residuals. The null hypothesis of no serial correlation must not be rejected for the GMM estimator to be consistent. Second, the Sargan and Hansen tests are performed to assess the validity of the instruments and the additional moment conditions required for system GMM. Failing to reject the null hypothesis indicates that the instruments are valid.

To enhance the efficiency of the system GMM estimation, we follow Roodman (2009) by restricting the number of instruments used, limiting them to three lags in the first-differenced equations and collapsing the instrument sets. Additionally, we incorporate time-specific effects in the growth regression equations to reduce the impact of cross-sectional error dependence in short dynamic panels, as recommended by Ding & John (2011).

5. Results and Discussion

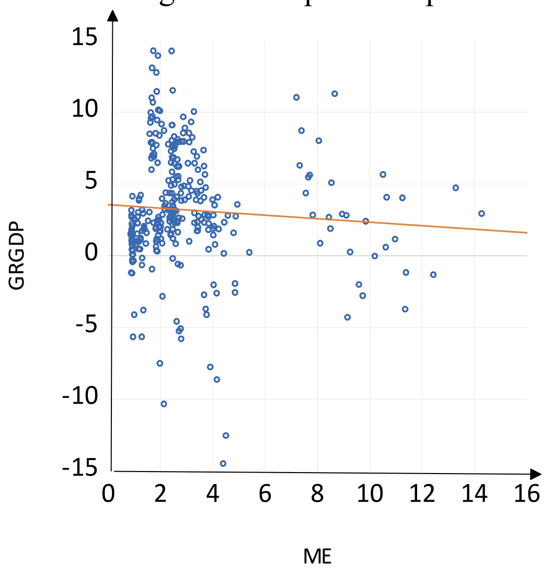
The descriptive statistics and correlation matrix are given in Table 2. The examination of results given in the upper part of Table 2 highlights that, according to the Jarque-Bera test, the variables are not normally distributed. The null hypothesis, asserting normality, is rejected at the one per cent significance level for all variables. Additionally, except for GRGDP, all variables are positively skewed. The kurtosis measure indicates leptokurtic characteristics across all variables. Standard deviations reveal significant variability in the variables, except for PGR. The lower part of Table 2 contains bivariate correlation among all variables. GRGDP has a positive correlation with FDINI, GCFR, and PGR; a low degree of negative correlation with ME and TRADE, and a medium degree of negative correlation with INFLATION. Figure 4 illustrates the scatter diagram between the GDP growth rate and various other variables.

Table 2: Descriptive Statistics and Correlation Matrix

Descriptive Statistics							
	GRGDP	**ME**	**TOPEN**	**INFLATION**	**FDINI**	**GCFR**	**PGR**
Mean	3.18	3.11	51.30	13.01	1.88	26.37	0.72
Median	2.72	2.49	50.88	2.21	1.48	24.01	0.53
Maximum	14.23	14.31	110.58	1490.42	12.73	46.66	3.96
Minimum	-14.53	0.88	15.72	-2.09	-1.79	14.83	-1.85
Std. Dev.	4.09	2.42	20.22	100.00	1.93	7.37	0.84
Skewness	-0.41	2.24	0.36	12.71	2.20	0.94	1.40
Kurtosis	4.98	7.95	2.69	173.93	10.40	3.07	5.64
Jarque-Bera	59.63	575.71	7.74	385717.90	957.19	46.12	191.37
Probability	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Observations	310	310	310	310	310	310	310
Correlation Matrix							
	GRGDP	**ME**	**TOPEN**	**INFLATION**	**FDINI**	**GCFR**	**PGR**
GRGDP	1.00						
ME	-0.07	1.00					
TOPEN	-0.08	0.23	1.00				
INFLATION	-0.32	0.05	0.17	1.00			
FDINI	0.19	-0.07	0.15	-0.07	1.00	0.00	
GCFR	0.50	-0.14	-0.07	0.05	0.00	1.00	0.10
PGR	0.18	0.70	0.08	-0.08	0.05	0.10	1.00

Source: Calculated by authors.

Figure 4: Graphical Representation of GRGDP and Other Variables



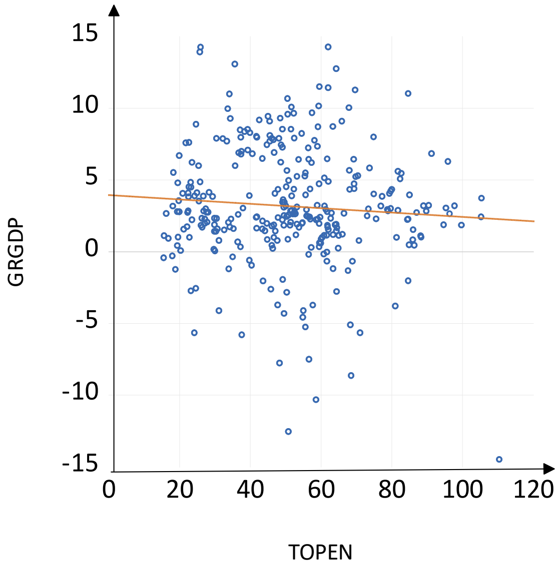
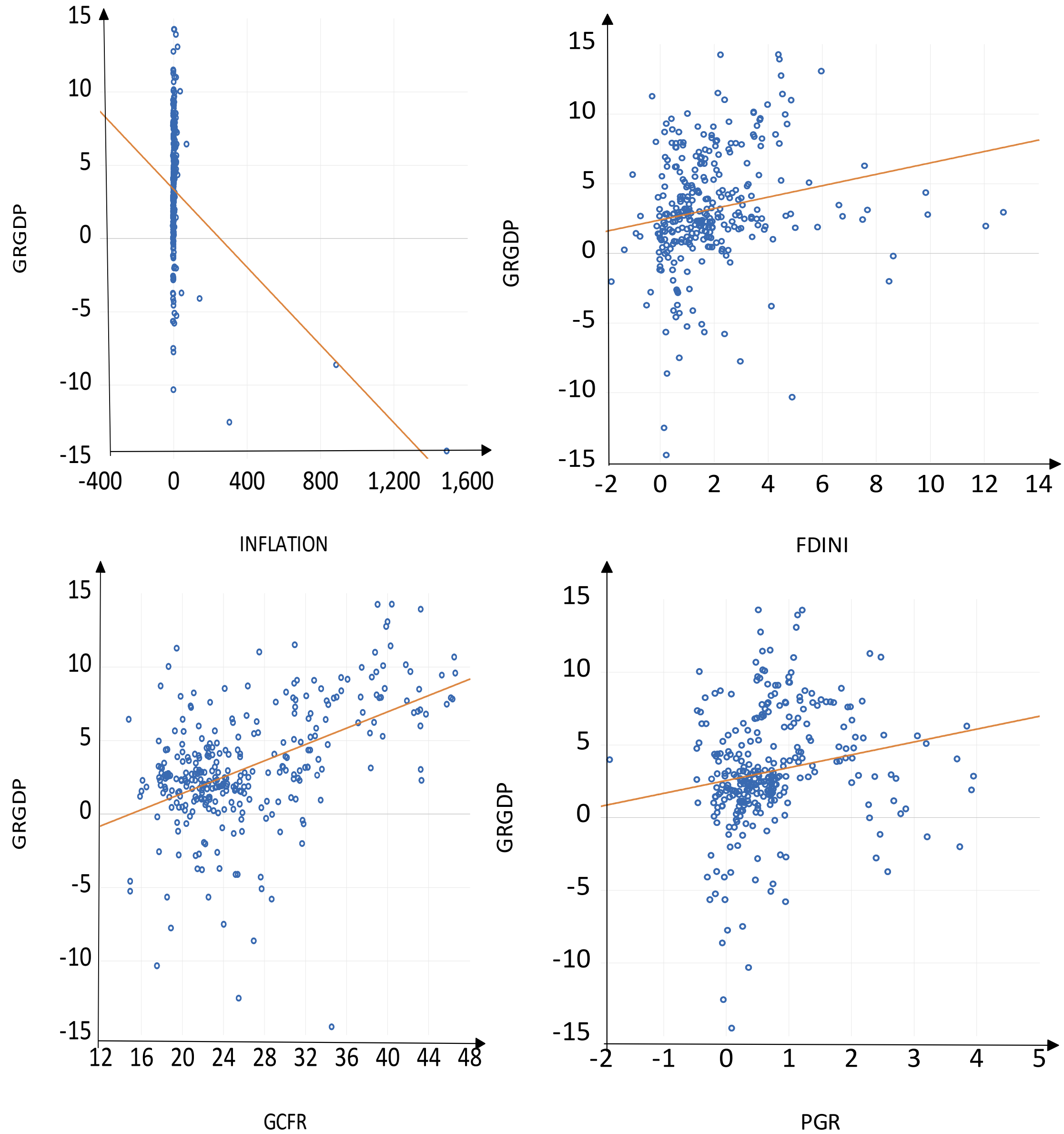


Figure 4: Graphical Representation of GRGDP and Other Variables (cont.)



Source: Prepared by authors.

Figure 4 shows that GRGDP is negatively related to INFLATION, ME and TOPEN, but it is positively related to GCFR, PGR and FDINI. Table 3 presents the results of the panel regression model estimated using three conventional methods.

Table 3: Model Estimated by POLS, FEM, and REM Methods

Dependent Variable: Real GDP growth rate			
	POLS Model	**FEM**	**REM**
ME	-0.150335	-0.937413***	-0.254532*
	(0.114807)	(0.271373)	(0.139272)
TRADE	-0.00102	0.001043	0.004826
	(0.009488)	(0.016400)	(0.011743)
INFLATION	-0.013142***	-0.0130278***	-0.013894***
	(0.001861)	(0.001933)	(0.001866)
FDINI	0.328010***	0.1476173	0.223585**
	(0.096723)	(0.107774)	(0.102313)

Dependent Variable: Real GDP growth rate			
	POLS Model	**FEM**	**REM**
GCFR	0.270902***	0.115882**	0.236834***
	(0.025885)	(0.055556)	(0.033659)
PGR	0.7792912**	0.244942	0.8035847 **
	(.321217)	(0.432494)	(0.360658)
C	-4.451669***	2.704775	-3.340341***
	(0.901725)	(1.95962)	(1.168797)
N	310	310	310
R-squared	0.4141	0.1535	0.4074
F value	35.69	12.36	
Prob > F	0.0000	0.0000	
Wald chi2			125.80
Prob > chi2			0.0000

*Note: Standard errors in parentheses; *, **, *** indicate significance at 10, 5, and 1 per cent level of significance, respectively.*

Source: Calculated by authors.

To determine the appropriate model for further analysis, model selection tests were conducted among the three models. The results of these tests are presented in Table 4.

Table 4: Model Selection

Test	Test statistic	p-value	Selected Model /Conclusion
F test	F = 6.16	0.0000	FEM
Hausman Test	$\chi^2 = 36.62$	0.0000	FEM
Breusch-Pagan LM test	$\chi^2 = 17.19$	0.0000	REM

Source: Calculated by authors.

Table 4 indicates that the FEM is deemed appropriate, prompting subsequent model diagnostic tests. The results of these diagnostic tests conducted on the FEM are displayed in Table 5.

Table 5: Model Diagnostic Tests

Test	Test statistic	p-value	Selected Model /Conclusion
Pesaran CSD Test	16.380	0.0000	Contemporaneous Correlation
Breusch-Pagan LM	$\chi^2 = 332.769$	0.0000	Presence of Cross Section Dependence
Woolridge Test	F = 0.071	0.7957	No Autocorrelation
Modified Wald Test	$\chi^2 = 57.50$	0.0000	Presence of Heteroscedasticity
Endogeneity	F = 35.687	0.0000	Presence of Endogeneity
Identification Test	$\chi^2 = 214.127$	0.0000	

Source: Calculated by authors.

The findings given in Table 5 explicitly reveal that the FEM exhibits issues with cross-section dependence, heteroskedasticity and endogeneity.

Further, to solve these problems and for the robustness of the model, the FGLS model is employed along with the first difference GMM and system GMM. The outcomes of these models are showcased in Table 6.

Table 6: Robustness check for the model

	FEM	**FGLS**	**DIF-GMM**	**SYS-GMM**
ME	-0.937413***	-0.0809513	-1.413113***	-1.26259**
	(0.271373)	(0.1428881)	(0.5611154)	(0.5153811)
TOPEN	0.001043	-0.0069271	0.0748384	0.0834603
	(0.016400)	(0.0113733)	(0.0796025)	(0.0904046)
INFLATION	-0.0130278***	- 0.0125288***	0.100612***	0.1317886***
	(0.001933)	(0.0028742)	(0.181729)	(0.0197203)
FDINI	0.1476173	0.3317484***	0.915616	0.1327718
	(0.107774)	(0.0972302)	(0.1341875)	(0.1411097)
GCFR	0.115882**	0.2983462***	0.7184021***	0.8046228***
	(0.055556)	(0.0267277)	(0.189361)	(0.1957504)
PGR	0.244942	0.8701338**	0.0038961***	-0.0767972
	(0.432494)	(0.3859789)	(0.4937678)	(0.5768485)
C	2.704775	-5.162304***		-3.494217***
	(1.95962)	(0.9097959)		(0.8449887)
Instruments			262	273
Sargan test			0.113	0.435
Hansen J-test			1.000	1.000
AR(1)			0.005***	0.004***
AR(2)			0.582	0.182

*Note: *, **, *** indicate significance at 10, 5, and 1 per cent level of significance, respectively.*
Source: Calculated by authors.

Table 6 compares four different estimation methods - FEM, FGLS, Difference GMM (DIF-GMM), and System GMM (SYS-GMM) for analysing the impact of military expenditure and control variables on economic growth for ten major countries of the world. Military expenditure has a negative and statistically significant effect on the dependent variable across most models. Specifically, the FEM and DIF-GMM estimations show a highly significant negative impact with coefficients of -0.937 and -1.413, respectively. The SYS-GMM method also indicates a significant negative effect, though slightly smaller in magnitude (-1.263). However, the FGLS estimation shows a negative but insignificant effect, suggesting that the negative relationship is sensitive to the model choice.

The effect of trade openness is insignificant across all models, implying that it does not have a statistically significant impact on economic growth in any of the estimations. This suggests that trade openness may not play a substantial role in influencing the dependent variable under the given conditions. Inflation shows a consistent negative and significant effect in the FEM and FGLS models, with coefficients of -0.013 and -0.013, respectively. However, in the GMM models, inflation has a positive and significant effect, which may indicate potential issues like endogeneity or model specification differences.

The effect of foreign direct investment is positive and significant in the FGLS model (0.332) but not significant in the other models, suggesting that its impact may vary based on the estimation technique used. Gross Capital Formation shows a positive and significant effect on economic growth in all models, with the magnitude increasing substantially in the GMM models. This indicates that gross capital formation is a robust and key driver in the context of the study. Population growth rate shows mixed results, being significant in the FGLS model but not in others, suggesting that its impact may not be consistent across different estimations.

In terms of diagnostic tests, the Sargan and Hansen J-tests indicate the validity of the instruments used in the GMM models, as the p-values are high, meaning we fail to reject the null hypothesis of instrument validity. The AR (1) test for first-order autocorrelation is significant, suggesting the presence of autocorrelation, while the AR (2) test is not significant, indicating that there is no second-order autocorrelation, thus supporting the consistency of the GMM estimators.

6. Conclusion

The debate surrounding the effect of military expenditure on economic growth remains inconclusive, lacking definitive evidence. This study seeks to contribute to the discourse by examining the impact of military expenditure on economic growth, using data from ten prominent countries spanning the period from 1992 to 2022. The countries under consideration are the USA, China, Russia, India, Saudi Arabia, the UK, Germany, France, South Korea, and Japan which collectively accounted for 75.2 per cent of the world's military expenditure in 2022. The study employed a panel data model, using Pooled OLS, FEM, and REM. Following model selection tests, it was found that FEM was the most suitable model. However, FEM suffers from issues of cross-section dependence and heteroskedasticity. To address these problems, the FGLS model along with the first difference GMM and system GMM was employed, effectively resolving the identified problems and robustness of the model. The study finds that military expenditure and gross capital formation are the most influential factors in this context, with military expenditure having a detrimental effect and gross capital formation contributing positively. The GMM estimators are validated by the Sargan and Hansen J-tests, confirming the reliability of the instruments used, and the absence of second-order autocorrelation supports the robustness of the GMM results. These findings provide a nuanced understanding of the dynamics at play and suggest that policy interventions should focus on optimising military expenditure and encouraging capital formation to achieve the desired outcomes. An important finding of the study is that military expenditure has a negative and significant effect on economic growth. This result is consistent with prior research by Chang et al. (2001), Tiwari & Tiwari (2010), Chang et al. (2011), Wijeweera & Webb (2011), Hou & Chen (2012), Dunne & Tian (2016), Kunu et al. (2016), Mangir & Kabaklarli (2016), and Cevik & Ricco (2017).

Consequently, the study advocates for global adherence to peaceful policies, emphasising the reduction of military expenditures. Redirecting scarce resources towards alternative areas is proposed as a strategy to foster economic growth. This approach is deemed essential for achieving sustainable and balanced economic growth, as excessive military expenditure at the expense of these sectors could yield adverse economic consequences.

The findings of this study suggest several important policy implications. Governments are advised to consider reallocating a portion of military expenditure towards sectors such as healthcare, education, and infrastructure, which are crucial for fostering long-term economic growth and sustainable development. By redirecting resources to productive investments, countries can enhance overall economic welfare. Additionally, the study advocates for the promotion of peaceful policies, as military expenditure was found to have a significant negative effect on growth. Prioritising diplomacy and conflict resolution could enable a more efficient allocation of resources to areas that directly contribute to economic prosperity. Policymakers are also encouraged to adopt a balanced fiscal strategy, carefully weighing military spending against other government priorities to avoid potential negative economic impacts from excessive defence budgets. Moreover, with foreign direct investment having a significant positive effect on growth, it is crucial to create a favourable business environment to attract investment and stimulate innovation. Capital formation and population growth, both of which significantly contribute to a nation's economic resilience, should also be incentivised through targeted policies.

Lastly, the limitations of this study include the use of aggregate data from multiple countries, which may overlook important country-specific factors like geopolitical threats or national security needs that could justify higher military spending. The effect of military expenditure on economic growth might vary due to the model used or data limitations, suggesting that more detailed research could explore differences between revenue and capital military expenditures. Additionally, the study relies on data from 1992 to 2022, and inconsistencies in reporting military expenditure could affect the accuracy of the findings. It also doesn't fully separate the short-term and long-term impacts of military spending, which may offer security benefits not immediately reflected in economic growth. Finally, factors such as political stability, international alliances, and technological advancements were not included but could influence the relationship between military spending and growth, offering scope for future research to explore these aspects.

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Appendix

Table A.1: Studies Showing Positive Effect of Military Expenditure (ME) on Economic Growth (EG)

Authors	Period & Countries	Variables	Methods	Findings
Benoit (1978)	1950-1965 (44 LDCs)	Growth in civilian product, Defence burden, Investment rate, aid	Rank correlation regression	Defence programs positively influence civilian productivity and EG
Landau (1994)	1969-1989 (71 LDCs)	Growth rate of GNP, Trade, Foreign debt, Life expectancy, ME	Cross-sectional regressions analysis, FEM	No evidence of a negative impact of ME on EG
Landau (1996)	(1950-1990) 17 OECD countries	GRGNP, ME share in GNP, per capita product relative to US, the weighted average of enrollment at level 3 of education, population GR, ratio of central gov debt to GNP, and time trend	Non-linear regression analysis	The effect of military expenditure on economic growth is non-linear, with faster growth at low levels of military expenditure and slower growth at higher levels, forming an inverted U-shape.
Kollias et al. (2007)	1961-2000 (EU countries)	GDP, ME	OLS, FEM, REM, Panel cointegration	Presence of positive feedback between ME and EG in LR
Pradhan (2010)	1988-2007 (India, China Nepal & Pakistan)	ME, EG, public debt	Cointegration, ECM	LR relationship exists between ME & EG
Pan et al. (2015)	1988-2010 10 Middle East Countries	Per capita GDP, ME, Real capital stock	Granger causality analysis	One-way Granger causality from ME to EG in Turkey, opposite in Kuwait, Lebanon, Egypt, and Syria, feedback in Israel, and no causality in Oman, Bahrain, Jordan, and Saudi Arabia.
Shahid & Saba (2015)	1995-2011 (56 countries)	GDP, ME, GFCF	FEM, REM Johansen Fisher panel cointegration	Boosting of EG through higher ME is neither an effective nor efficient way
Adbel-Khalek et al. (2019)	1980-2016 (India)	GDP, ME, GE, aid, Exports	Johansen cointegration, VECM, Granger causality	Absence of a causal relationship between ME & EG
Dimitraki & Win (2021)	1970-2015 Jordan	GR of GDP per capita, ME, Non-defence GE, population	GH cointegration, ARDL, ECM	Positive SR and LR relationships between ME & EG
Mohanty et al. (2020)	1970-2016 (India)	PCGDP, GDCF, Labour force participation rate, Capital ME, Revenue ME, Trade openness	ARDL, Toda-Yamamoto, Granger causality	Capital ME exerts a positive impact on EG, causation between ME & EG.

Source: Prepared by authors.

Table A.2: Studies Showing Negative Effect of Military Expenditure (ME) on Economic Growth (EG)

Authors	Period & Countries	Variables	Methods	Findings
Chang et al. (2001)	1952-1995 (Taiwan and Mainland China)	GNP, ME	Cointegration analysis, VAR, VECM, Granger-causality tests, IR,	ME not being strongly exogenous relative to EG
Tiwari & Tiwari (2010)	India	GDP per capita, ME, GDS, trade per capita	Johansen cointegration analysis, VECM, Granger causality test	a bi-directional causality between GDP and ME
Chang et al. (2011)	1992-2006 (90 countries)	Real GDP growth per capita, ME per capita, Investment to GDP ratio, Population growth	DPM, Granger causality	ME hinders EG
Wijeweera & Webb (2011)	1988-2007 South Asian countries	Real GDP growth, ME	Panel cointegration, Granger causality	ME has a minimal effect on EG
Hou & Chen (2012)	1975-2009 35 developing countries	GDP per capita, investment, Population GR, Years of schooling, ME	OLS, FEM, FGLS, System GMM	ME has a significant negative effect on EG
Dunne & Tian (2016)	1988-2014 97 countries	GDP per capita, ME, Capital stock, Population	Augmented Solow growth model with Harrod-neutral technical progress	ME has a negative effect on EG
Kunu et al. (2016)	1988-2012 (12 Middle-Eastern Countries)	GDP growth rate, FDI, Population GR, ME	REM	ME has a negative effect on EG
Mangir & Kabaklarli (2016)	1991-2013 (16 countries)	GDP per capita, GE, GCF, ME, Life expectancy	FEM, REM	Negative effect of ME on EG
Cevik & Ricco (2017)	1984-2014 112 countries	Growth rate of real GDP per capita, ME, Investment, Average years of schooling	Panel data FEM and system GMM Methods	No significant impact of ME on EG

Source: Prepared by authors.