

Military Expenditure-Economic Growth Dynamics: Fresh Insights from Sub-Saharan Africa

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ABSTRACT

The study assesses Sub-Saharan Africa's economic growth-military spending nexus with a special bias towards impact and causality. The study focuses on 38 sub-Saharan African economies in the 1990-2021 era. The empirical evidence of the study is based cross-sectional dependence and homogeneity tests, nonlinear estimation and granger non-causality techniques. The study established that military expenditure adversely impacts growth in the sub-region, and that a bidirectional causal relationship exists in the military expenditure-economic growth relationship. The study complements the relatively scanty and extant literature on the impact and causality permeating the dynamics in military expenditure and its influence on economic performance. Policy implications and mix from the study has far-reaching application in highly security-vulnerable regions in the world.

Keywords: Military, Africa, Reverse causality, Panel, Growth, Expenditure

JEL Classification: H55, O11

1. Introduction

Military expenditure (*ME* henceforth) is a growing concern for most economies and has broadly resonated owing to growing chunk of human and financial resources utilized. Undoubtedly, *ME* is a controversial issue in the public fiscal sphere. Broadly, it seems like a leakage in the flow or utilization process of public goods and services since public resources which would have been channeled into other productive fields including

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health, education, infrastructure (soft/hard), agriculture and other sectors are now being utilized to ensure that a volatile-prone economy is in check. Such *ME* has distorted the market prices of factors of production thereby undermining economic growth momentum. It implies that *ME* has opportunity costs with resources diversion from more productive sectors (Yesilyurt & Yesilyurt, 2019).

In contrast, a school of thought, *military Keynesianism*, opined that in the presence of excess market capacity, economic growth is stimulated by *ME* through a spill-over effect. Military Keynesianism hinges on advanced technologies in warfare research and development (R&D). This positive *ME*-economic growth nexus has been supported in several studies (Lobont et al., 2019; Herra & Gentilucci, 2013; Raju & Ahmed, 2019; Kollias et al., 2007; Khalid & Noor, 2018; Benoit, 1978). It is argued that *ME* generates employment directly and through spillover of human and technological resources spur economic growth (Heo and Yin, 2016; Mearsheimer and Walt, 2016; Posen, 2014; Gholz and Daryl, 2001). It is essential to state that the impact of *ME* depends on factor intensity of labour and capital since *ME* is either capital-intensive or labour-intensive in nature (Kentor et al., 2012) and any shift towards increased capital-intensive *ME* will spur growth and vice versa.

This study focuses on the sub-Saharan Africa (SSA). The region is not insulated against internal and external security challenges. Due to its strategic geopolitical position and its wealth/resources (human and natural), the region is highly susceptible to security challenges, thus prompting huge *ME*. African countries have witnessed unprecedented increase in security challenges in recent times, thus justifying governments' increase in *ME* in the continent, since *ceteris paribus*, the *ME* is expected to cushion adverse impacts of security challenges on growth (Kyriakos & Christos, 2021). According to the 2022 Global Terrorism Index, SSA accounted for some 48 percent of terrorism-driven deaths globally. SSA is fast emerging the epicenter of global terrorism with the increasing waves of terrorist attacks and emergences of different terrorists' groups in the region. A recent report of the African Development Bank (AfDB) opined that conflicts and violence are rising exponentially in Africa. More than 18,000 conflicts and over 32 million persons were internally displaced in 2021 (AfDB, 2022). In Africa, security challenges resulted in \$39.7 billion *ME* in 2021 with SSA gulping about 51 percent (4.1 percent increase over that of 2020). This

was approximately 1.08 percent of the sub region's GDP. In addition, statistics showed that *ME* in SSA amounted to \$20.3 billion in the 2022 fiscal year. This figure was a decrease of 7.3 percent compared with 2021 *ME* expenditure (Da Silva et al., 2022).

With the appalling scenario presented above, it is quite critical to assess the *ME*-economic growth relationship in SSA especially given recent increase in security challenges in the sub region. Other than some recent works such as those by Saba and Ngepah (2019) and Biyase and Zwane (2016), most recent studies done on the subject in the sub region have been carried out on country-specific basis (for instance, Biyase et al., 2022; Laniran & Ajala, 2021; Batchelor et al., 2000). The use of updated economic data is thus essential in evaluating up-to-date welfare implications of *ME* on growth. This constitutes the main thrust of this study. This paper employed panel data for growth indicator (per capita GDP) and *ME* in our estimation. Using this growth indicator capture the effect of *ME* not only on the general economy but also on individual welfare.

To achieve its objective, the structural/organizational framework following this section is as follows: section 2 presents review of related literature. Theoretical underpinnings and discussion of methods employed are discussed in section 3, while discussion of results and conclusion are presented in sections 4 and 5, respectively. Expected findings and policy implications will potentially harness *ME* positive influence on economic performance in the sub region.

2. Literature Review

There are scores of empirical studies that are geared and targeted at evaluating the *ME*-economic growth nexus across economies (developing, emerging and developed). Existing studies on the *ME*-economic growth nexus have been inconclusive, possibly due to different countries or panel of economies employed, scope of study adopted or methodologies utilized. This thus makes a robust appraisal and comparison of the issue highly difficult. Explicitly, the first series of empirical studies were carried out in the 1970s (see Benoit, 1978, 1973, 1972). These studies opined expenditure in the military sector adversely affect growth, and causality runs from the expenditure components to growth. In general, the empirical literature can be thematized into five categories: expenditure boosts growth; expenditure inhibits growth;

causality extends from expenditure to growth; causality extends from growth to expenditure; and no causality between expenditure and growth. We observed that there were no significant differences in findings and policy implications among empirical studies. While some studies show a positive relationship between *ME* and growth, others depict a negative trajectory. In the same vein, some studies show no causality between *ME* and growth, while others show causality though with different causal directions.

On one hand, some studies were country-specific (for instance, Uddin & Shafiq, 2023; Okwoche, 2022; Emmanouilidis & Karpelis, 2021; Dimitraki & Win, 2021; Maheswaranathan & Jerusha, 2021; Aziz et al., 2021; Tao et al., 2020; Mokoena et al., 2020; Abdel-Khalek et al., 2020; Michael & Gavilanes, 2019; Vitali, 2018; Sheikh et al., 2017; Manchester, 2017; Gokmenoglu et al., 2015; Saroja & Eliyathampy, 2014; Shahbaz et al., 2013; Atesoglu, 2009; Halicioglu, 2004; Batchelor et al., 2000; among others). While on the other hand, some studies are panel in nature (for instance, Raifu & Aminu, 2023; Rajeshwari, 2022; Susilo et al., 2022; Gomez-Trueba et al., 2021; Syed, 2021; Dudzevičiūtė et al., 2021; Nugroho & Purwanti, 2021; Almajdob & Marikan, 2021; Loveide, 2020; Gravalanes & Michael, 2020; Azam, 2020; D'Agnostino et al., 2019; Youssef, 2019; Khidmat et al., 2018; Karadam et al., 2017; Dash et al., 2016; Destek & Okumus, 2016; Paparas et al., 2016; Aziz & Asadullah, 2016; Korkmaz, 2015; Awaworyi & Yew, 2014; Hou & Che, 2013; Pradhan, 2010; Ando, 2009; Kollias et al., 2004; Dakurah et al., 2001). These studies adopted several research methods and scope of study, and the panel data studies spanned across Africa, Asia, America and Europe.

On country-specific basis, Uddin and Shafiq (2023) employed data of Bangladesh. The study found that a percent increase in *ME* resulted in a 0.74 percent increase in the long run, showing a positive impact of *ME* on growth. The study of Laniran and Ajala which utilized the autoregressive distributed lag (ARDL) model on Nigerian data between 1981 and 2017 also found a positive long run nexus. This conforms to a previous study by Enimola and Akoko (2011). Nwidobie et al. (2022) also found a positive and negative nexus between *ME* and growth in the short run and long run, respectively, in Nigeria between 1982 and 2020.

On the other hand, *ME* negatively impacts growth in several studies. Tao et al. (2020) employed structural break between 1996-1999 and 2002-2004 using Romanian data and found that crowding-out effects of *ME* on private investments resulted in a negative impact of *ME* on growth. Adopting the vector autoregressive (VAR) model, Adegoriola (2021) found that *ME* does not contribute significantly to growth between 1981 and 2018 in Nigeria, while Dunne and Skons (2011) found that *ME* hinders growth in the United States. A possible reason for the negative effect is the re-allocative effect of *ME* (Pieroni, 2009).

It is imperative to point out that studies which employed panel datasets also showed contrasting results. The results from an analysis of 35 developing countries by Hou and Che (2013) between 1975 and 2009 utilizing the system GMM technique showed a negative *ME* effect on economic growth. A similar conclusion was arrived at by Ali and Abdellatif (2013). Their study covered MENA countries between 1987 and 2012. The same was true in the studies of Azam (2020) which appraised 35 non-OECD countries between 1998 and 2019; D'Agnostino et al. (2019) which investigated 109 non-high-income countries between 1998 and 2012; Korkmaz (2015) which employed the data of 10 Mediterranean countries between 2005 and 2012; and Nugroho and Purwanti (2021) which appraised 27 lower-middle income countries between 2002 and 2018 utilizing the system GMM.

On the other hand, several panel data studies showed a positive *ME* effect on economic growth. Raifu and Aminu (2023) investigated 14 MENA countries between 1981 and 2019 utilizing the method of moments quantile regression and found that *ME* is growth-enhancing among the countries. Wiksadana and Sihaloho (2021) employed the fixed effect general least squares (FEGLS) method among selected Asian countries between 2013 and 2017, and found a positive relationship between *ME* and growth. The studies of Yildirim et al. (2005) that investigated economies in the Middle East and Turkey between 1989 and 1999 employing the cross-section and dynamic estimation techniques; Khidmat et al. (2018) that employed data of 12 emerging countries of South East Asia; and Syed (2021) that employed data of India, China and Pakistan, all showed *ME* growth-enhancing effects. The same conclusion was reached by other studies (for instance, Susilo et al., 2022; Awaworyi & Yew, 2014; Ando, 2009).

There are varying conclusions as regard correlation and causal relationship between *ME* and growth. For instance, employing the Poisson Pseudo-Maximum Likelihood (PPML) and Instrument Variable (IV) estimation methods on 77 economies from different regions and income groups, Youssef (2019) found a negative correlation between *ME* and growth. For Dudzevičiūtė et al. (2021), there were varying patterns of correlation across the Baltic countries between 2000 and 2018. The study of Karadam et al. (2017) on Middle Eastern countries and Turkey between 1988 and 2012 opined that the *ME*-growth was non-linear and negative.

Rajeshwari (2022) utilizing the ARDL methods on a comparative analysis between India and Pakistan between 2000 and 2018, found a long run relationship between *ME* and growth in both economies. In India, causality runs from *ME* to growth; while the reverse was the case for Pakistan in the long run. Whereas, there was no evidence of short run *ME*-growth nexus in India, the reverse was the case for Pakistan. The study of Gomez-Trueba et al. (2021) employed data spanning from 2005 to 2018 for NATO's economies utilizing the Arellano Bond estimator. The various countries exhibited various results. Some of the countries clearly show no significant causal relationship between *ME* and growth. That corroborated a previous study by Mokoena et al. (2020) which explored the *ME*-growth nexus in South Africa between 1961 and 2018.

Dakurah et al. (2016) employed the data of 62 developing countries utilizing the Granger causality method. The study found unidirectional causality for 23 countries, bidirectional causality for 7 countries, and no causality for 18 countries. The study of Dash et al. (2016) on the BRIC blocs between 1993 and 2014 employing the panel cointegration and causality methods showed that causality runs from *ME* to economic growth. Okwoche (2022) also found the same direction of causality in Nigeria utilizing the Toda-Yamamoto-Dolado-Lutkepohl Granger non-causality test. But a reverse causality running from growth to *ME* was found in the studies of Gokmenoglu et al. (2015) that employed the Johansen co-integration and Granger causality methods in Turkish data spanning between 1988 and 2013, and Maheswaranathan and Jerusha (2021) that utilized Sri Lankan data between 1990 and 2019. Whereas a bi-directional causality between *ME* and growth was observed in the findings of Azam (2020).

The study of Destek and Okumus (2016) was more detailed. Employing data of BRICS (Brazil, Russia, India, China and South Africa) and MIST (Mexico, Indonesia, South Korea, and Turkey) countries between 1990 and 2013 in a bootstrap panel Granger causality framework, the study found a positive and negative unidirectional causality from *ME* to growth for China and Turkey, respectively. The *feedback hypothesis* was confirmed for Russia, while the *neutrality hypothesis* was established for South Africa, South Korea, India, Indonesia and Brazil.

However, it should be noted that some empirical studies showed no causal link between *ME* and growth. These studies included Abdel-Khalek et al. (2020), Manchester (2017), Batchelor et al. (2000), among others. These results cut across regions and research methods.

Essentially, a possible reason for varying results in the *ME*-growth nexus analysis may be the scope in the study, as well as country- or regional-specific characteristics. However, we observed several research gaps in the *ME*-growth nexus literature. Majority of studies were country-specific and policy implications are thus greatly limited. To the best of our knowledge, none of the previous studies has jointly investigated the effects that inflation and trade openness may exert on the *ME* burden in SSA. Previous panel data studies such as Gyimah-Brempong (1989), Mohammed (1993), Olaniyi (2002), Smaldone (2006), Aikaeli and Mlamka (2010), and Saba and Ngepah (2019) failed to capture the Granger-causality in heterogeneous panel. In addition, previous studies did not adequately prove the presence or otherwise of the *feedback hypothesis* in SSA. This study employed a comprehensive and up-to-date data available in analyzing the *ME*-growth relationship.

3. Data and Methodology

3.1. Theoretical Underpinning

The study adopted the theoretical model of Dunne et al. (2005) and also applied in Dunne and Tian (2015) which hinges on the Solow augmented growth model. Dunne et al. (2005) noted that most economic theories do not fully integrate *ME* into their formulation, thus there is no standard framework which is both consistent and flexible upon which the *ME*-growth nexus can be estimated. In addition, though recent studies consistently lend support for a negative *ME*-growth nexus, there is no general consensus on the relationship (Dunne & Tian, 2015). For instance,

while in many poor economies, security challenges hinder growth, *ME* may be determined or driven by other factors. There may be rent-seeking behaviour in *ME* resulting in more growth-retarding security challenges (Dunne et al., 2005; Dunne & Tian, 2015). It was argued that such devastating effects can be contingent on factors such as *ME* financing pattern, degree of utilization of *ME* finance options and *ME* effectiveness. Since these determining factors differ across countries, the effect on growth is expected to vary accordingly. The Dunne et al. (2005) model focuses on cross-country growth models.

The model assumes a Harrod-neutral technical progress. The model also assumes that *ME*-total output ratio ($m=ME/Y$) affects the level of factor productivity level through a given effect level of efficiency parameter. It should be stated that the efficiency parameter determines change in the Harrod-neutral technical progress. By implication, steady state growth rate in the long run is unaffected by a perpetually sustained change in *ME* share (m). However, m can potentially affect income (per capita) steady state growth path trajectory permanently. Thus, logically, m has the potential to alter positive or negative transitory growth rates in any new steady state equilibrium path.

The model begins with a typical neoclassical Cobb-Douglas (CD) production function which accommodates a technological progress variable assumed to be Harrod-neutral. The production function is expressed as;

$$Q(t) = K(t)^\alpha [A(t)L(t)]^{1-\alpha} \quad (1)$$

In the above expression, aggregate real income is given as Q , real capital (K) stock, and labour (L) input. The technical parameter, denoted by A , can be expressed as;

$$A_t = A_0 e^{gt} m_t^\theta \quad (2)$$

As previously defined, m is the *ME* share as a ratio of total output; g denotes the rate of technical progress which is Harrod-neutral and exogenously determined; θ denotes income-long run military expenditure elasticity in the steady state level. One important variable that influence output in any growth model is physical capital accumulation, k . Given the constant labour force growth rate (n), exogenously savings rate (s) and a

constant depreciation rate (δ) assumptions of a standard Solow model, changes in capital accumulation (k) is given as;

$$\dot{k}_e(t) = s_K k_e^\alpha(t) - [n + g + \delta]k_e \Leftrightarrow \frac{\partial \ln k_e}{\partial t} s e^{(\alpha-1)\ln k_e} - (n + g + \delta) \quad (3)$$

In which k_e refers to the effective capital-labour ratio (K/AL); while α denotes constant capital-output ratio. Given these variables, Equation (4) expresses the steady state level effective capital-labour ratio (k_e) as;

$$\tilde{k}_e^* = \left[\frac{s}{n+g+\delta} \right]^{\frac{1}{1-\alpha}} \quad (4)$$

By applying a truncated Taylor series expansion technique to linearize Equation (3) and substituting the resulting expression in Equation (4), the expression below is obtained;

$$\frac{\partial \ln k_e}{\partial t} = (\alpha - 1)(n + g + \delta)[\ln k_e(t) - \ln k_e^*] \quad (5)$$

Drawing from the above equation, it implies that the output equation will be;

$$\frac{\partial \ln q_e}{\partial t} = (\alpha - 1)(n + g + \delta)[\ln q_e(t) - \ln q_e^*] \quad (6)$$

Note that Equation (6) captures the effective labour per output transitory dynamics in steady state level. We can also derive per effective labour output steady state level drawing from Equation (4) as;

$$\tilde{q}_e^* = \left[\frac{s}{n+g+\delta} \right]^{\frac{1}{1-\alpha}} \quad (7)$$

It should be noted that Equation (8) seeks to capture the transitory changes/dynamics in output per effective labour unit. We can therefore expand Equation (6) to obtain;

$$\frac{\partial \ln q_e}{\partial t} = [(\alpha - 1)(n + g + \delta)[\ln q_e(t)]] + [(\alpha - 1)(n + g + \delta)\ln q_e^*] \quad (8)$$

Following Dunne et al. (2005) which employed a forward integration approach, Equation (8) can be solved to obtain;

$$\ln q_e(t) = e^z \ln q(t-1) + (1 - e^z) \ln q_e^* \quad (9)$$

Where $z = (\alpha-1)(n + g + \delta)$. In order to incorporate the technological parameter into the output expression, Equations (2) and (7) are incorporated into (9) and this results in;

$$\ln q(t) = e^z \ln q(t) + (1 - e^z) x \left\{ \ln A_0 + \frac{\alpha}{1-\alpha} [\ln s - \ln(n + g + \delta)] \right\} + \theta \ln m(t) - e^z \theta \ln m(t-1) + [t - (t-1)e^z]g \quad (10)$$

All variables remain as previously defined. Following Dunne et al. (2005), we estimate a panel regression model. It should be noted that the Dunne et al. (2005) model argued that *ME*-economic growth nexus will depend on shifts in both security threat factors and productivity factors. When the model was applied in South Korea and Taiwan where productivity and security threats were high, there was a positive *ME*-growth effect. In SSA, where security threats were high and *ME* was ineffective, there was low growth. The reverse was the case for Japan and Germany after World War II. In their cases, low *ME* was accompanied with high growth rate.

3.2. Model

In consonance with the empirical studies of Desli and Gkoulgkoutsika (2021) and Dunne et al. (2005), the econometric model (Equation. 11) is specified to capture the *ME* and growth relationship:

$$PCG_{it} = \pi_i + \pi_1 PCG_{it}(-1) + \pi_2 MEX_{it} + \pi_3 INF_{it} + \pi_4 OPN_{it} + \varepsilon_{it} \quad (11)$$

Where *PCG* is economic growth (captured by real GDP per capita); *PCG*(-1) is the lag of *PCG* incorporated to control growth dynamics (Canh, 2018); *MEX* (*ME* is captured as the total *ME* as a percent of GDP); *OPN*, trade openness (proxied by total trade-GDP ratio); and *INF* (inflation). Individual country and period are captured by subscripts *i* and *t*, respectively; and an error term, ε .

3.3. Panel cointegration tests (PCTs)

The PCTs were employed to show the existence of long run relations among the variables (Pedroni, 2004; Kao, 1999; Pedroni, 1999). The panel regression below was proposed:

$$q_{i,t} = \sigma_i + \delta_i t + \sigma_{1i} p_{1i,t} + \sigma_{2i} p_{2i,t} + \dots + \sigma_{Zi} x_{Zi,t} + \mu_{i,t} \quad (12)$$

for $t = 1, \dots, T; i = 1, \dots, N; z = 1, \dots, Z$

In Equation (12), observations are captured by T, N captures the units of countries; and the number of variables is represented by Z. There are seven (7) and five (5) statistics in Pedroni (2004) and Kao (1999) cointegration tests, respectively.

3.4. Panel autoregressive distributed lagged (ARDL) model

Basically, we adopted the panel ARDL technique since this technique can be utilized irrespective of the level of stationarity as long as it is either I (0), I (1) or a mixture. It also produces viable outcomes in small (Narayan, 2005). The unrestricted error correction ARDL model is specified thus;

$$PCG_{i,t} = \sum_{j=1}^p \gamma_{i,j} PCG_{i,t-j} + \sum_{j=0}^q \sigma_{i,j} X_{i,t-j} + \mu_i + \varepsilon_{it} \quad (13)$$

Where X is a vector of regressors, i refers to individual country and t is the period. μ_i captures fixed effects. Equation (13) can be reparameterized as:

$$\begin{aligned} \Delta PCG_{i,t} = & \omega_i PCG_{i,t-1} + \alpha_i X_{it} \\ & + \sum_{j=1}^{p-1} \gamma_{i,j} \Delta PCG_{i,t-j} + \sum_{j=0}^{q-1} \sigma_{i,j} \Delta X_{i,t-j} + \mu_i + \varepsilon_{i,t} \end{aligned} \quad (14)$$

Where,

$$\left. \begin{aligned}
\omega_i &= - \left(1 - \sum_{j=1}^p \gamma_{i,j} \right) \\
\alpha_i &= \sum_{j=0}^q \sigma_{i,j} \\
\gamma_{it} &= - \sum_{r=j+1}^p \gamma_{ir}, \quad j = 1, 2, 3, \dots, \quad p-1 \\
\sigma_{it} &= - \sum_{r=j+1}^q \sigma_{ir}, \quad j = 1, 2, 3, \dots, \quad q-1
\end{aligned} \right\} \quad (15)$$

The speed of adjustment is captured by ω . This represents speed of convergence to equilibrium state in the presence of shock(s).

3.5. Data, Sources and Operationalization of Variables

Data employed in this study were collected for the period of 1990-2021 for 38 SSA countries. Our data and scope of economies selected was constrained by availability of the *ME* variable. We observed missing observations in *ME* across the countries. For instance, Guinea, Equatorial Guinea, Gambia, Guinea-Bissau (no information between 1961 and 1978; Equatorial Guinea (no observations for 1996-2006, 2010-2013, 2015 and 2017); Cabo Verde (no data between 1961 and 1984); Democratic Republic of Congo (several missing observations between 1980 and 1995) are just a few countries with such missing observations. Actually, only 10 countries (Burkina Faso, Cameroon, Ghana, Kenya, Malawi, Mauritius, Nigeria, South Africa, Tanzania and Uganda) have a balance panel dataset on *ME*. The study recognized the importance of employing a balanced panel since this reduces the noise introduced by country-specific heterogeneity (Baltagi, 2005; Cameron & Trivedi, 2009). To improve the robustness and confidence level of our findings, we constrained our data to 1990 and 2021.

Countries sampled in the study included South Africa, Gambia, Mauritius, Cabo Verde, Benin, Ghana, Central African Republic, Angola, Zambia, Senegal, Sierra Leone, Burkina Faso, Equatorial Guinea, Uganda, Rwanda, Gabon, Mauritania, Togo, Mozambique, Ethiopia,

Malawi, Cameroon, Kenya, Niger, Mali, Congo, Rep., Cote d'Ivoire, Nigeria, Sudan, Zimbabwe, Dem. Rep. Congo, Somalia, Guinea-Bissau, Liberia, Namibia, Tanzania, South Sudan and Guinea. The data employed in the study included real GDP per capita, *ME* (as a percent of GDP), trade openness and inflation. Both the trade openness and inflation variables were included in the study since both exerts a strong influence on economic growth and *ME*. Real GDP per capita is derived by dividing of the summation of a country's economic output by its population and adjusted for inflation. This variable aids in comparing the standard of living of the citizenry over time. This variable has been utilized in previous studies (Mohanty et al., 2017; Paparas et al., 2016; Ali & Abdellatif, 2013; and Dunne & Nikolaidou, 2012).

There are several measures of *ME*. These include *ME* (percent of general government expenditure), *ME* (current USD) and *ME* (current LCU). However, we adopted the *ME* (as a percent of GDP) because “*data on defence expenditure should be supplemented by additional, mainly gross domestic product (GDP)...*” (United Nations, 2005, pg. 46). The *ME* (as a percent of GDP), otherwise known as “military burden” can effectively capture the relative economic cost of *ME* on an economy. This variable has also been extensively employed in previous studies in similar context (Dunne & Tian, 2015; Paparas et al. 2016; Ali & Abdellatif, 2013).

The inflation variable captures the annual percentage change average consumer's cost of acquiring goods and services. The inclusion of this variable in the model sprang from the fact that rising cost of living result in chaos and conflicts which can potentially increase *ME* of a country. This variable was included in similar context in Wang (2023), Emmanouilidis and Karpetsis (2021), and Tzeng et al. (2008). Trade openness variable was calculated by dividing country's total trade (summation of exports and imports) by GDP. It was opined that this variable is appropriately fitting to include in the model since there are suggestions that conflicts are minimal in countries with high trade volume, and that trading in war implements/technologies can affect growth of a country (Polachek, 2007; Yakovlev, 2007). Previous studies such as Raifu and Aminu (2023), Dramane (2022) and Dizaji (2019) employed the trade openness in evaluating the *ME*-growth nexus.

The data for the study were elicited from secondary data sources. The *ME* (percent of GDP) data was drawn from *Stockholm International Peace*

Research Institution (SPIRI). ME data drawn from SIPRI covers the NATO definition, which includes all expenditures (current and capital) on the armed forces, including peacekeeping. The other data were elicited the data from the World Development Indicators (WDI) database.

4. Empirical Results

4.1. Cross-sectional Dependence (C-D) and Test for Slope Homogeneity

The C-D tests ensure that arriving at partial results are avoided (Pesaran, 2004). We adopted the Blomquist & Westerlund (2013) and Pesaran & Yamagata (2008) methods in testing for homogeneity. Table 1 presents the results obtained:

Table 1. C-D & homogeneity tests

Panel 1: C-D test.				
Test	PCG	MEX	OPN	INF
Breusch-Pagan LM	115.97 (0.0000)	129.77 (0.0000)	110.09 (0.0000)	171.83 (0.0000)
Pesaran Scaled LM	19.11 (0.0000)	121.53 (0.0001)	67.28 (0.0000)	95.03 (0.0000)
Bias-corrected scaled LM	18.17 (0.0000)	109.73 (0.0000)	67.17 (0.0001)	55.38 (0.0001)
Pesaran CD	6.49 (0.0000)	47.08 (0.0000)	9.87 (0.0001)	14.79 (0.0000)
Panel 2: Homogeneity test				
Statistics	Blomquist & Westerlund (2013)		Pesaran & Yamagata (2008)	
Delta	7.018 (0.000)		14.008 (0.000)	
Delta_adj.	9.586 (0.000)		18.473 (0.000)	

Source: Authors' compilation

Note: p-value in parenthesis

The results in Table 1 Panel 1 showed that the variables exhibit strong evidence of cross-sectional dependence. The results in Panel 2 rejects the null hypothesis of homogenous slope coefficients. We thus accept that the slope coefficients were heterogeneous.

4.2. Panel Unit Root (PUR) Tests

In this study, we utilized several PUR tests to ascertain the property of the data employed. These PUR tests included the LLC, IPS, and ADF-Fisher tests (Levin et al., 2002; Im et al., 2003; Maddala & Wu, 1999). Table 2 presents the results of the PUR tests.

Table 2. PUR results

Tests	Variable	Level		First Difference		Decision
		C	C + T	C	C + T	
LLC	PCG	-11.09***	-5.17***	-	-	Stationary
	MEX	-18.61***	-12.05***	-	-	"
	OPN	5.17	3.23	-19.70***	-15.09***	"
	INF	-4.21***	-2.88***	-	-	"
IPS	PCG	-3.74**	-2.07**	-	-	"
	MEX	-12.74***	-9.34***	-	-	"
	OPN	9.08	5.57	-21.07***	-33.61***	"
	INF	-12.91***	-8.54***	-	-	"
ADF-Fisher Chi-square	PCG	128.06***	105.18***	-	-	"
	MEX	136.42***	221.47***	-	-	"
	OPN	14.09	23.11	257.19***	219.11***	"
	INF	73.43***	72.08***	-	-	"

Source: Authors' compilation

Note: ***, ** significance at 1% and 5%, respectively. C and C + T denote constant and constant + trend.

The results in Table 2 depicts a mixture of variables integrated of levels 0 and 1 [that is, $I(0)$ and $I(1)$]. Other than the openness variable, OPN , which attained stationarity at first difference, stationarity was achieved by other variables at level, thus validating the utilization of the panel ARDL.

4.3. Panel cointegration tests (PCTs)

Given the outcome of the PURTs, we utilized panel cointegration test. Table 3 contains the empirical output.

Table 3. PCTs results

Pedroni (1999) test	Coefficient	Kao (1999) test	Coefficient
Panel v -statistic	8.11***	DF	-1.81*
Panel ρ -statistic	-12.09**	DF ρ	-3.51***
Panel non-parametric (PP) t-statistic	-5.19***	DFt	-6.07***
Panel parametric (ADF) t-statistic	-113.97***	DF ρ^*	-3.94***
Group ρ -statistic	-16.21***	ADFt*	-1.99**
Group non-parametric t-statistic	-4.99***		
Group parametric t-statistic	-3.61***		

Source: Authors' compilation from STATA 15 output

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

The PCTs results show a cointegrated relationship between the variables based on their significance levels. This implies a pervasive long-run nexus between growth and military expenditure.

4.4. Panel ADRL Method

We therefore utilized the panel ARDL to estimate short and long run dynamics simultaneously and at the same controlling for inherent heterogeneity peculiar to country-specific factors. This technique also has the potential to correct for endogeneity along with serial correlation. We present the *Pooled Mean Group* (PMG) estimate in Table 4.

Table 4. Results of PMG estimation

Dependent Variable: PCG	Coefficient
Long Run Equation	
MEX	-0.517*** (0.129)
OPN	0.014*** (0.003)
INF	-0.231** (0.088)
Short Run Equation	
ECM(-1)	-0.539*** (0.055)
Δ PCG(-1)	0.047*** (0.012)
Δ MEX	-0.086*** (0.017)
Δ MEX(-1)	-0.037** (0.012)
Δ OPN	0.217* (0.118)
Δ OPN(-1)	0.003 (0.002)
Δ INF	-0.051** (0.019)
Δ INF(-1)	-0.018 (0.027)

Source: Authors' compilation from STATA 15 output

Note: standard errors brackets; ***, **, * significance at 1%, 5%, and 10%, respectively.

The results show that *ME* has an adverse long run effect on economic growth. Specifically, long run coefficient estimate of -0.517 is obtained for the *ME* variable and is statistically significant. This implies that a 1 percentage point rise in *ME* will dampen economic growth by 0.517 percentage points. This negative effect is also obtained in previous panel studies such as Dada et al. (2023), Becker and Dunne (2021), Hou and Che (2013), and Olaniyi (2002). It is also in tandem with country-specific studies such as Biyase et al. (2022) and Ather and Ali (2014). However, it contrasts the findings of Raifu and Aminu, Susilo et al. (2022), and Ando (2009).

The variable OPN (openness) positively influence economic growth in both short run and long run periods. Interestingly, a long run 1 percentage point rise in OPN stimulated economic growth by 0.014 percentage point, *ceteris paribus*. This finding was in tandem with Raifu and Aminu (2023) and Dramane (2022). Conversely, inflation negatively impact economic growth in both runs. This finding corroborated previous studies (Wang, 2023; Mohanty et al., 2017; Ali & Abdellatif, 2013). The variable of speed of adjustment shows that about 53.9 percent of equilibrium is restored within a fiscal year following a disequilibrium.

4.5. Causality Test

There is a possibility of a reverse effect, running from economic growth to *ME*. This is plausible given that increased economic performance can potentially spur military expenditure especially with abundance resources in the economy. We thus employed the novel Juodis et al. (2021) Granger non-causality test. This test has an advantage given that it can accommodate both heterogeneous and homogenous panel data. We thus present the Half-Panel Jackknife estimator. The results presented in Table 5 present a two-way-causality between *ME* and growth.

Table 5. Granger non-causality test results

Panel A						
BIC =		-691.3579	HPJ Wald test:		2.6328	p-value_HPJ: 0.0311
PCG	Coefficient	SE.	z.	P>z	[95% CI]	
L1.	0.0153	0.0011	6.38	0.000	-0.0012	0.0438
Panel B						
BIC =		-148.3815	HPJ Wald test:		65.5731	p-value_HPJ: 0.0000
MEX	Coefficient	SE	z	P>z	[95% CI]	
L1.	-0.6117	0.0368	-12.71	0.000	-0.5201	-0.3947

Source: Author's compilation

Note: L1 denotes number of lags; standard error is given as SE;

The dependent variable *MEX* and independent variable *PCG* are presented in Panel A, while in Panel B, *PCG* and *MEX* are assumed dependent and independent variables, respectively. From Panel A, the null hypothesis that *PCG* does not Granger-cause *MEX* is rejected at the 5 percent level of significant. By implication, there is a causality running from *PCG* to *MEX* in at least one of the sampled countries. In the same vein, the null hypothesis which states that *MEX* does not Granger-cause *PCG* is rejected at the 1 percent significance level. By implication, that *ME* has the capacity to determine future economic growth in the sub region, *ceteris paribus*. The causality methods employed in this study has a huge advantage over those of Saba and Ngepah (2019) which investigated panel of 35 African economies between 1990 and 2015 and appraised the economic growth-*ME* causal relationship on country-by-country basis. Our findings mirrored those of Mohammed (1993). Explicitly, our finding validated the existence of the *feedback hypothesis* in SSA.

5. Conclusion

In this study, we examined the SSA's military expenditure-economic growth relationship between 1990 and 2021. The study found that expenditure on military infrastructure/sector has not positively influence economic growth. In addition, a bidirectional military expenditure-economic growth causality was established with essential policy implications, validating the *feedback hypothesis* in SSA. In this study, we do not intend or attempt to recommend whether or not or how SSA economies should alter/change their military expenditure. Such decisions are determined by a vector of other factors that are either regional-based or country-specific. However, we suggest that policymakers should conscientiously consider the economic implications of any military expenditure their economy seeks to undertake. Specifically, there should be a deliberate attempt to reallocate funds to other viable sectors including infrastructure investments, education and health in the sub region to stimulate economic growth. The sub region should avoid borrowing to fund military expenditure, since this can adversely affect inflation. Instead, there should be an adjustment in tax policy to fund such expenditure with accruing negative spill-overs in the general economy. There is also need to synergize security efforts in the sub region to ensure

inter- and intra-security structure that will ensure enhanced economic performance.

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