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Does Income Heterogeneity Influences the Military Expenditure-Economic Growth Nexus? Evidence from Sub-Saharan Africa

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ABSTRACT

With security challenges bedeviling Sub-Saharan Africa, military expenditure has been increasing exponentially through the years. Such an increase has potential effects on economic growth across the region such effects vary with income level. The aim of this study is to investigate the role of income heterogeneity in the military expenditure-economic growth relationship in 33 Sub-Saharan African economies for the period 2000 to 2021. The study utilizes the Dynamic Ordinary Least Square (DOLS) since the technique corrects for endogeneity, serial correlation, and simultaneity problems, as well as mitigates the potential omitted variable bias problem. The empirical results show the adverse effect of military expenditure on economic growth among the SSA economies. The study also found that the negative growth effect of military expenditure is more evident among low-income countries. The study, therefore, recommends that the sub-Sahara African region should adopt country-specific military initiatives, as well as, harness regional military cooperation to ensure inclusive growth, among other policy options.

ملخص

مع التحديات الأمنية التي تواجه منطقة أفريقيا جنوب الصحراء الكبرى، شهدت النفقات العسكرية زيادة هائلة على مر السنين. فلهذه الزيادة آثار محتملة على النمو الاقتصادي في المنطقة،

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وتختلف هذه الآثار حسب مستوى الدخل. يهدف هذا البحث إلى استكشاف دور التباين في الدخل في العلاقة بين النفقات العسكرية والنمو الاقتصادي في 33 اقتصادا من اقتصادات أفريقيا جنوب الصحراء الكبرى خلال الفترة من عام 2000 إلى 2021. واستخدمت الدراسة طريقة المربعات الصغرى العادية الدينامية (DOLS)، نظرا لقدرتها على تصحيح تأثير المتغيرات الداخلية والارتباط التسلسلي ومشاكل التزامن، وكذلك التخفيف من مشكلة انحياز المتغير المتجاهل. وتشير النتائج التجريبية إلى الأثر العكسي للنفقات العسكرية على النمو الاقتصادي في هذه الاقتصادات. وكما أظهرت الدراسة أن التأثير السلبي للنفقات العسكرية على النمو كان أكثر وضوحا بين البلدان ذات الدخل المنخفض. وعليه، توصي الدراسة بأن تعتمد دول أفريقيا جنوب الصحراء الكبرى مبادرات عسكرية مخصصة لكل بلد، إلى جانب تعزيز التعاون العسكري الإقليمي لضمان نمو شامل، فضلا عن خيارات سياساتية أخرى.

RÉSUMÉ

Étant donné que le rôle joué par les petites et moyennes entreprises (PME) dans l'économie malaisienne est de plus en plus reconnu, cette étude donne un aperçu des pratiques environnementales, sociales et de gouvernance (ESG). En particulier, cette étude examine les déterminants des pratiques de durabilité parmi les PME en Malaisie. Le questionnaire a été distribué à 200 propriétaires de PME de la région nord de la Malaisie. Les résultats de l'étude révèlent que les facteurs internes, tels que la sensibilisation, les connaissances et la culture organisationnelle, contribuent de manière positive et significative aux pratiques d'intégration de la durabilité dans les activités commerciales des PME. En outre, la variable de la concurrence est le seul facteur externe qui influence de manière significative les PME dans la mise en œuvre de pratiques de durabilité dans leurs activités. Cette étude conclut que les PME devraient donner la priorité à la durabilité pour améliorer leur réputation et répondre aux attentes des consommateurs. Étant donné le faible impact des réglementations gouvernementales et des avantages financiers sur la motivation des PME à adopter des pratiques de durabilité, cette étude recommande que les décideurs politiques renforcent les initiatives de durabilité, car cette approche peut aider les PME de Malaisie à développer des pratiques commerciales durables qui contribuent au bien-être économique, environnemental et social.

Keywords: ESG, Sustainability, Small and medium enterprises (SMEs), Malaysia.

JEL Classification: L10, L26, M14, M21

1. Introduction

Sub-Saharan Africa confronts an apparently expanding and evolving spectrum of security challenges. Although the security environment is inherently dynamic and continuously shifting, the circumstances in which these threats emerge share several common characteristics. While interstate conflict is on the decline, intrastate conflicts, such as civil wars, are on the rise, with some Sub-Sahara African countries becoming hubs of security crisis even beyond their national boundaries (Palik et al., 2020). In Sub-Saharan Africa, between-countries conflicts continue to be the primary cause of insecurity. In recent years, there have been a surge in terrorism and militia activities in the Sub-Sahara African region which has resulted in economic instability (Africa Center, 2021). Furthermore, there has also been a spike in within-country security crisis which has resulted in deaths, economic challenges and displacement of persons (Efayena & Olele, 2024a; Palik et al., 2020), in addition to riots and transnational organized criminal activities which have positioned the region second in terms of criminality worldwide (Cilliers, 2018; ENACT, 2021).

From the Keynesian viewpoint, military expenditure (*MILEX* henceforth) is seen as a crucial element of government spending, which involves injecting economic and financial resources into the economy. The *MILEX* is expected to favourably impact the economy via a multiplier effect. For instance, economic growth may be stimulated via the provision a secured environment to economic activities. The externalities accruing from this include infrastructural development such as schools, roads, hospitals and other amenities. These will improve human capital for economic development in the long run. On the contrary, some studies suggest a negative *MILEX*-economic growth nexus (Efayena et al., 2024; Anifowose, 2019; Desli & Gkoulgkoutsika, 2021; Dramane, 2022). It was argued that the negative nexus can be attributed to crowd-out effect of investment orchestrated by reduced saving rate since economic and financial resources are diverted to *MILEX* instead of investment opportunities.

Although a plethora of studies exist on the *MILEX*-growth nexus in some developing countries and how *MILEX* impacts macroeconomic variables including savings, investment, and poverty (Efayena & Olele, 2024b; Becker & Dunne, 2023; Kuol & Amegboh, 2022; Aikaeli & Mlamka,

2010), most of the previous studies are concentrated on Asian economies (see Waszkiewicz, 2020; Abdel-Khalek et al., 2020; Caruso & Di Domizio, 2017; Zhao et al., 2017). Furthermore, the majority of past studies primarily concentrate on either the causal link between *MILEX* and economic growth or solely on the impact of *MILEX* on growth. Only a limited number of studies have undertaken a comprehensive investigation, which involves an appraisal of the impact and causal relationship between *MILEX* and economic growth in countries of SSA. Moreover, some of the previous studies exhibited certain methodological limitations. For instance, certain studies rely on cross-sectional data, which may not adequately capture the dynamic relationship between *MILEX* and economic growth over time. Specifically, the limitations of employing cross-sectional data were explicitly presented in several studies (see Caselli et al., 1996; Ghirmay, 2004; Odhiambo, 2008; Quah, 1993).

The cross-sectional approach overlooks the varying levels of development among countries, neglecting the country-specific effects intrinsic to the *MILEX*-growth relationship. Additionally, there is evidence that this approach may yield inconsistent and misleading estimates due to potential biases arising from heterogeneity among the studied countries. Considering the heterogeneity of a variable yields outcomes has far-reaching policy implications (Efayena & Buzugbe, 2021). Notably, previous studies combine data from both low- and middle-income countries, assuming that the estimated relationships apply uniformly to both income groups. In some cases where panel datasets have been employed, econometric challenges peculiar to panel data such as cross-sectional dependency, have not been adequately addressed. Furthermore, such studies which rely on random and fixed effects estimation have not accounted for the issue of endogeneity.

To address the limitations of previous studies, especially in the paucity of studies on the mediating influence of income heterogeneity on the *MILEX*-economic growth nexus, this study has utilized the dynamic ordinary least squares (DOLS) approach alongside cross-section dependence tests (Pesaran CD, Pesaran scaled LM, Breusch-Pagan LM, and Baltagi et. al., (2012). Given the weaknesses associated with first-generation unit root tests in the presence of cross-section dependence, the current study has used the second generation unit root tests associated with Bai and Ng (2005), Panel Analysis of Non-stationarity in

Idiosyncratic and Common components (PANIC), and Pesaran (2007) CIPS (cross-sectionally augmented IPS) alongside the first generation unit root tests to examine whether the variables used in this study are conclusively I(0) or I(1).

The contribution of this paper to existing studies is prominently two-fold. The study basically disaggregated its analysis putting into consideration the heterogeneous income levels of economies in SSA. It also investigated both the impact and causal nexus between *MILEX* and growth. The remaining part of the paper is organized as follows. Section 1 provides a brief review of the literature that is related to our work and Section 2 describes the data and the variables included in the regressions. Section 3 presents the empirical results. The last part of the paper concludes the paper.

2. Literature Review

Summarizing the plethora of literature on *MILEX*-economic growth is challenging due to its complexity. Various studies differ in their theoretical perspectives, empirical methodologies, coverage of countries and time periods, and overall quality and statistical significance, further adding to the difficulty of providing a concise overview. However, this section attempts to present a comparative analysis of previous studies based on their findings. Most studies have found a negative relationship between *MILEX* and economic growth regardless of time coverage and methodology. For instance, Azam (2020) empirically assessed the influence of *MILEX* on economic growth in a panel comprising 35 non-OECD countries from 1988 to 2019. The panel autoregressive distributed lag (ARDL), pooled mean group (PMG) techniques and fixed-effect and least squares estimators indicate a distinct negative impact of *MILEX* on economic growth. By identifying a structural break between 1996-1999 and 2002-2004, Tao et al. (2020) found a debilitating effect of MILEX on economic growth in Romania. Hassan et al. (2003) analyzed the influence of *MILEX* on economic growth and foreign direct investment in five out of the seven member countries of the South Asian Regional Cooperation Council (SARCC) employing a panel data spanning from 1980 to 1999. A negative nexus was established.

Similar conclusions were reached by the studies of Anifowose (2019) which investigated the nexus between *MILEX* and economic growth among BRICS economies between 1984 and 2017; Raju and Ahmed

(2019) which examined the nexus in India between 1980 and 2017 in Pakistan and China between 1989 and 2017, employing cointegration analysis and causality tests; Desli and Gkoulgkoutsika (2021) which investigated the worldwide effect of *MILEX* on economic growth between 1960 and 2017 employing a dynamic common correlated effects estimator; Lanrui et al. (2022) which analyzed the nexus in Pakistan between 1972 and 2018 employing a nonlinear NARDL technique. These results contrasted those of Uddin and Shafiq (2023) which investigated the *MILEX*-economic growth nexus in Bangladesh and found a positive impact. Specifically, a one percent rise in *MILEX* led to a 0.74 percent long-term growth increase.

Interesting, some panel data studies have established a positive *MILEX*-economic growth nexus. For instance, Khidmat et al. (2018) explored the nexus among 12 emerging economies in South East Asia between 1990 and 2015 utilizing the random and fixed effect models. The study found that *MILEX* positively spurs economic growth. A similar conclusion was reached in the study of Raifu and Aminu (2023) which was focused among 14 MENA economies between 1981 and 2019 employing the moments quantile regression. The study concluded that regardless of the *MILEX* variable employed, the effect remains positive, prompting the assertion that *MILEX* is both growth-enhancing and productive. Almajdob and Marikan (2021) investigated the relationship between *MILEX* and economic growth in four key Arab Spring countries. The study utilizes data from a balanced panel covering the period from 2000 to 2014. The findings from the Kao cointegration analysis indicate the presence of a long-run equilibrium between economic growth and *MILEX* across all countries. Additionally, the FMOLS analysis demonstrates a notable and positive impact of *MILEX* on the economic growth among the countries. A similar conclusion was reached in the study of Wiksadana and Sihaloho (2021) which focused on a panel of Asian economies between 2013 and 2017 utilizing the fixed effect general least squares (FEGLS) technique, as well as, that of Syed (2021) which focused on the economies if Pakistan, China and India.

It should be noted that several panel data African studies showed a negative *MILEX*-economic growth nexus. For instance, Dramane (2022) investigated the nexus among the G5 Sahel economies with a VAR model between 2000 and 2018. Similar findings were reach in the study of Iheonu and Ichoku (2022) which was carried out among 24 African

economies between 2001 and 2018. Other panel studies include Saba and Ngepah (2019) which employs the GMM, SGMM and bivariate heterogeneous panel causality estimation techniques in a balanced panel of 35 African economies, as well as, Saba and Ngepah (2018) which employed the panel causality analysis.

Notably, there are some country-specific studies that established a positive *MILEX*-economic growth nexus in Africa. These include the studies of Ajefu (2015) which investigated the nexus in Nigeria employing the Johansen Cointegration approach; Biyase et al. (2022) which investigated the nexus in South Africa employing the ARDL and bounds test; Raifu (2022) which examined the nexus in Nigeria between 1970 and 2019 utilizing the ARDL and FEVD methods; Saba (2022) which analyzed the relationship in South Africa between 1960 and 2018 in an ARDL framework; Oyerinde and Fagboro (2020) which further incorporated the effect of institutional quality on the nexus in Nigeria, utilizing data spanning from 1984 to 2017 in the ARDL framework; and Apanisile and Okunlola (2014) which also utilized the ARDL bound approach analyzing the scenario in Nigeria.

The study conducted by Egwaikhide and Ohwofasa (2009) explored the relationship between *MILEX* and economic growth in Nigeria, disaggregating *MILEX* into recurrent and capital components. The findings consistently demonstrated a positive association between *MILEX* and economic growth in all examined scenarios. While Anyanwu and Aiyedogbon (2011) utilized cointegration and vector error correction mechanism techniques to examine the correlation between *MILEX* and economic growth in Nigeria. The results indicated a positive relationship between *MILEX* and economic growth, both in the long run and the short run. The study of Ajala and Laniran (2021) also found similar pattern in the *MILEX*-economic growth nexus in Nigeria, employing annual time series data spanning from 1981 to 2017. The autoregressive distributed lag (ARDL) estimation technique was utilized and the findings reveal a statistically significant positive long-run association between MILEX and economic growth. This contrasted the findings of Adegoriola (2021) which adopted the vector autoregressive (VAR) in the 1981-2018 period and found that *MILEX* adversely impact economic growth in Nigeria.

A brief review of the literature revealed that the *MILEX*-economic growth nexus is far from conclusive, with some studies asserting a positive relationship and others proffering a negative stance. It can also be argued

panel data studies previously carried out in the African continent (Dramane, 2022; Iheonu & Ichoku, 2022; Saba & Ngepah, 2019; Saba & Ngepah, 2018, among others) have their shortcomings. Some African studies were solely focused on causality (for instance, Rajeshwari, 2022; Okwoche, 2022; Maheswaranathan & Jerusha, 2021; Dash et al., 2016; Dakurah et al., 2001; Gokmenoglu et al., 2015) which limited the extent of their policy implications. To the best of our knowledge, none of the previous studies has considered the effect of income level or classification on the impact of *MILEX* on economic growth in SSA. Thus, inferences drawn from such studies are limited in scope, since they do not put into consideration the level of income of the individual country under analysis. There is a high possibility that the income level of a country will impact the *MILEX*-economic growth nexus. Thus, this study will incorporate the income heterogeneity in appraising the relationship.

3. Data and Methodology

3.1. Theoretical Framework

The study utilized the theoretical theory proposed by Dunne et al. (2005) and extended by Dunne and Tian (2015), which centers around the Solow augmented growth model. Dunne et al. (2005) observed that existing economic theories do not adequately incorporate *MILEX* into their structure, resulting in the absence of a standardized framework that is simultaneously consistent and adaptable for estimating the relationship between *MILEX* and economic growth. Furthermore, despite a consistent body of recent research supporting a negative relationship between *MILEX* and growth, there is no unanimous conclusion on this association (Dunne & Tian, 2015). For example, in numerous underdeveloped economies, growth is impeded by security issues, while factors other than *MILEX* may play a role in determining or influencing it. Rent-seeking behavior within the *MILEX* sector may give rise to additional security challenges that hinder growth (Dunne et al., 2005; Dunne & Tian, 2015). It has been argued that the magnitude of such detrimental effects can depend on factors like the financing pattern of *MILEX*, the extent to which *MILEX* finance options are utilized, and the effectiveness of *MILEX*. As these determining factors vary between countries, the impact on growth is expected to differ accordingly.

The model incorporates the assumption of Harrod-neutral technical progress, where the level of factor productivity is influenced by the

MILEX-total output ratio (m = *MILEX*/Y) through a specified efficiency parameter. It is important to note that the efficiency parameter determines the extent of change in Harrod-neutral technical progress. Consequently, a continuously sustained change in the *MILEX* share (m) does not affect the steady state growth rate in the long term. However, the trajectory of income (per capita) steady state growth can be permanently affected by m. Thus, m has the potential to modify the transitory growth rates, whether positive or negative, in any new equilibrium path.

The model initiates by utilizing a conventional neoclassical Cobb-Douglas (CD) production function that incorporates a technological progress variable, assumed to be Harrod-neutral. It is important to acknowledge that according to the model proposed by Dunne et al. (2005), the relationship between *MILEX* and economic growth is contingent upon changes in both security threat factors and productivity factors. When the model was implemented in countries like South Korea and Taiwan, characterized by high levels of productivity and security threats, a positive effect on economic growth was observed. Conversely, in regions such as Sub-Saharan Africa (SSA), where security threats were prevalent and *MILEX* was ineffective, the growth rate remained low. However, a contrasting scenario was observed in countries like Japan and Germany after World War II, where low levels of *MILEX* coincided with high growth rates.

3.2. Model Specification

Following the expenditure-growth literature, the study estimates the equation:

$$growth_{it} = \delta + \pi \left(\frac{MILEX}{GDP}\right)_{it} + \varphi(controls)_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (1)$$

Where growthit is proxied by GDP per capita growth rate of country i in period t; *MILEX*/GDP is military expenditure as a share of GDP (percent); $controls_{it}$; refers to the control variables (log of inflation, fixed investment/GDP, government consumption/GDP, trade openness, and armed conflict) and ε_{it} is the error term. The variable α represents a complete set of country fixed effects, which account for the influence of any time-invariant country-specific characteristics, while the variable β signifies a complete set of year fixed effects. As is standard in expenditure-growth models, the *MILEX* variable is treated as endogenous.

The control variables utilized are informed by previous studies investigating the *MILEX*-economic growth nexus (for instance, Iheonu & Ichoku, 2022; Saba & Ngepah, 2019; Saba, 2022; Dunne & Tian, 2015).

The joint effect of endogeneity, country-specific unobserved factor, and conditional convergence are factors that may cause biased estimates in expenditure-economic growth models (Hansen & Tarp, 2001).

Thus, the model presented in Equation (1) will be estimated using the DOLS methodology. The advantage of the DOLS is that it can correct endogeneity, serial correlation, and simultaneity problems via differenced leads and lags (Maji et al., 2019; Efayena & Olele, 2021). In this way, the DOLS can generate unbiased estimates (Maji et al., 2019; Kao & Chiang, 2000; Bellocchi et al., 2021). In the same vein, the DOLS has been found to outperform both the OLS and FMOLS estimators.

3.3. Data

The data employed in the study include the variables of interest which is *MILEX* (proxied by military expenditure as a share of GDP) and economic growth, EG (proxied by log of per capita GDP). The control variables include log of inflation, fixed investment/GDP (%), government consumption/GDP (%), trade openness. The dependent variable is *MILEX*. Military expenditure was normalized with GDP to account for military burden of a country. The armed conflict variable, CONFL, is notably an important variable. If there was any kind of armed conflict in the given year, the dummy variable receives a value of 1, and if none, it receives a value of 0.

The study uses annual time-series data that were obtained from the World Development Indicators (2021) CD-ROM, Uppsala Conflict Data Program Control for Conflict, and the Stockholm International Peace Research Institute (SIPRI) database, for a sample of 33 SSA countries selected based on data availability for all the indicators used in the study. The data set used spans from 2000 to 2021. The overall sample used for estimation comprises the 33 Sub-Saharan African countries selected for this study. To account for variations in income levels, the study categorized the Sub-Saharan African countries into two groups based on the World Bank classification: MICs (middle-income countries) and LICs (low-income countries) as shown in Table 1. The years of coverage and the countries included in the analysis are determined by the availability of data.

Table 1: Classification of Countries

Middle-income countries (MICs)		Lower-income countries (LICs)	
Botswana	Angola	Benin	Guinea
Equatorial Guinea	Cameroon	Burkina Faso	Malawi
Gabon	Comoros	Burundi	Mozambique
Mauritius	Congo Rep	CAR	Niger
Namibia	Cote D'Ivoire	Chad	Rwanda
Seychelles	Ghana	Congo Dem Rep	Sierra Leone
South Africa	Kenya	Ethiopia	Tanzania
Senegal	Nigeria	Togo	Uganda
Sudan			

Source: World Bank (2020)

4. Empirical Results

In order to highlight the importance of the heterogeneity of income in the *MILEX*-economic growth nexus, the study first report the results where aggregate data was utilized to estimate the pooled sample, and then compare them with the results where the data is disaggregated by the level of income. Table 7 shows the results for the full sample, low-income countries, and middle-income countries. To facilitate the discussion, the study first analyzes the descriptive statistics, cross-section dependence and other properties of the employed dataset.

4.1. Descriptive Analysis

The utilized dataset provided several interesting descriptive statistics for the different income categories. Table 2 present the descriptive statistics.

Table 2: Descriptive statistics

	Mean	St. Dev.	Min.	Max.
Log (per capita GDP)	1293.07	1607.38	113.47	9623.43
Military expenditure/GDP (%)	38.45	25.91	2.06	173.24
Log (inflation)	5.85	7.73	-3.58	51.73
Fixed investment/GDP (%)	931.06	1030.70	104.81	5361.05
Government consumption/GDP (%)	1208.13	1599.04	109.83	6002.13
Trade openness (%)	59.04	20.07	20.73	117.68
Conflict dummy	0.37	0.48	0	1

Source: Authors' compilation

The results in Table 2 showed that MILEX showed a wide variation with a mean of 38 percent and a standard deviation of 26 percent. Furthermore, the statistics of the armed conflict dummy show that 37 percent of total

year observations has conflict issues between 2000 and 2021. The SSA region has an average per capita GDP of $1,293, while fixed investment and government consumption averaged $931 and $1,208, respectively. In addition, the region's inflation rate averages 6 percent.

Table 3 shows the correlation results of the variables. This analysis is meant to show the level of association among the variables.

Table 3: Correlation matrix

	GDPPC	**MILEX**	**INF**	**FI**	**GC**	**TO**	**CONF**
GDPPC	1.00						
MILEX	-0.08	1.00					
INF	-0.09	0.15	1.00				
FI	0.10	-0.11	-0.06	1.00			
GC	0.18	-0.09	-0.11	0.23	1.00		
TO	0.01	0.20	0.18	0.16	0.08	1.00	
CONF	-0.03	0.13	0.12	-0.05	-0.21	0.05	1.00

Source: Authors' compilation

Note: *GDPPC, MILEX, INF, FI, GC, TO, and CONF denote log (per capita GDP), military expenditure/GDP (%), log (inflation), fixed investment/GDP (%), government consumption/GDP (%), trade openness (%), and conflict dummy, respectively*

The magnitude of the correlation of the variables in Table 3 shows a relatively low correlation. Therefore, multicollinearity does not present an econometric issue in the estimation. Interestingly, MILEX has a negative correlation with economic growth, but a positive correlation with inflation, trade openness, conflict dummy, fixed investment, and government consumption.

4.2. Cross-sectional Dependence

Before examining the unit root test of the variables employed, it is essential to conduct a panel cross-section dependence test. This is done to consider the potential cross-section dependence among the countries included in the study. Cross-section dependence may arise from various factors specific to countries. Previous studies have highlighted that neglecting cross-section dependence in panel estimations can have significant implications, introducing considerable bias and size distortions (Pesaran, 2006). To address this concern, four tests for cross-section dependence have been utilized to examine its presence in the estimation: Breusch-Pagan LM, Pesaran scaled LM, Bias corrected scaled LM, and Pesaran CD. The results of the cross-section dependence test can be found in Table 4.

Table 4: Cross-section dependency tests

	Breusch-Pagan LM	**Pesaran scaled LM**	**Bias-corrected scaled LM**	**Pesaran CD**
Overall sample of SSA				
Log (per capita GDP)	872.23*** (0.0000)	82.63*** (0.0000)	80.04*** (0.0000)	15.99*** (0.0000)
Military expenditure/GDP (%)	611.45*** (0.0000)	32.72*** (0.0000)	31.11*** (0.0000)	13.27*** (0.0000)
Log (inflation)	810.99*** (0.0000)	34.04*** (0.0000)	33.62*** (0.0000)	14.62*** (0.0000)
Fixed investment/GDP (%)	419.25*** (0.0000)	23.40*** (0.0000)	22.51*** (0.0000)	11.73*** (0.0000)
Government consumption/GDP (%)	437.53*** (0.0000)	29.17*** (0.0000)	27.02*** (0.0000)	11.99*** (0.0000)
Trade openness (%)	259.19*** (0.0000)	20.39*** (0.0000)	19.11*** (0.0000)	9.63*** (0.0000)
Conflict dummy	304.07*** (0.0000)	24.88*** (0.0000)	20.09*** (0.0000)	12.71*** (0.0000)
Low-income countries (LICs)				
Log (per capita GDP)	239.03*** (0.0000)	35.83*** (0.0000)	35.11*** (0.0000)	13.62*** (0.0000)
Military expenditure/GDP (%)	201.72*** (0.0000)	31.65*** (0.0000)	31.00*** (0.0000)	12.31*** (0.0000)
Log (inflation)	219.38*** (0.0000)	34.62*** (0.0000)	34.21*** (0.0000)	13.05*** (0.0000)
Fixed investment/GDP (%)	197.41*** (0.0000)	30.74*** (0.0000)	30.02*** (0.0000)	9.87*** (0.0000)
Government consumption/GDP (%)	200.31*** (0.0000)	31.06*** (0.0000)	30.69*** (0.0000)	11.76*** (0.0000)
Trade openness (%)	121.08*** (0.0000)	29.88*** (0.0000)	29.08*** (0.0000)	7.34*** (0.0000)
Conflict dummy	101.52*** (0.0000)	26.09*** (0.0000)	26.62*** (0.0000)	6.15*** (0.0000)
Middle-income countries (MICs)				
Log (per capita GDP)	471.88*** (0.0000)	48.34*** (0.0000)	47.62*** (0.0000)	13.99*** (0.0000)
Military expenditure/GDP (%)	401.75*** (0.0000)	40.81*** (0.0000)	40.07*** (0.0000)	12.83*** (0.0000)
Log (inflation)	455.04*** (0.0000)	43.89*** (0.0000)	43.77*** (0.0000)	13.42*** (0.0000)
Fixed investment/GDP (%)	382.62*** (0.0000)	39.99*** (0.0000)	39.17*** (0.0000)	11.83*** (0.0000)
Government consumption/GDP (%)	391.47*** (0.0000)	40.20*** (0.0000)	40.01*** (0.0000)	12.77*** (0.0000)
Trade openness (%)	148.34*** (0.0000)	37.36*** (0.0000)	37.10*** (0.0000)	9.72*** (0.0000)
Conflict dummy	139.04*** (0.0000)	35.32*** (0.0000)	34.48*** (0.0000)	8.83*** (0.0000)

Source: Authors' compilation

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

The findings presented in Table 4, which encompass the full sample, as well as low-income countries (LICs) and middle-income countries (MICs), indicate that the four cross-section dependence tests have predominantly rejected the null hypothesis of no cross-section dependence in both LICs and MICs. This implies the presence of cross-section dependence in the dataset employed. As a result, these results suggest employing second-generation unit root tests to adequately address the influence of cross-section dependency.

4.3. Panel Unit Root Tests

Since cross-section dependence has been identified, it is crucial to employ second-generation panel unit root tests when conducting the unit root tests. The outcomes of the stationarity tests can be found in Tables 5.

Table 5: Panel unit root tests

	Bai & Ng – PANIC		**Pesaran-CIPS**	
	Level	**First Difference**	**Level**	**First Difference**
Overall sample of SSA				
Log (per capita GDP)	-0.2419	-3.6713***	-0.4178	-4.5231***
Military expenditure/GDP (%)	-0.1925	-3.2672***	-0.2769	-3.3061***
Log (inflation)	-0.7262	-3.3831***	-0.3711	-5.5318***
Fixed investment/GDP (%)	-0.3719	-2.5639**	-0.7113	-3.0457***
Government consumption/GDP (%)	-0.0236	-2.6743**	-0.2991	-2.5992**
Trade openness (%)	-0.4321	-3.6117***	-0.4631	-2.5349**
Conflict dummy	-0.0416	-2.5528**	-0.7034	-3.4305***
Low-income countries (LICs)				
Log (per capita GDP)	-0.1673	-3.3481***	-0.2388	-6.1162***
Military expenditure/GDP (%)	-0.5628	-3.1193***	-0.7832	-5.3892***
Log (inflation)	-0.2871	-2.0143**	-0.3791	-3.9903***
Fixed investment/GDP (%)	-0.3118	-2.2318**	-0.6932	-4.3870***
Government consumption/GDP (%)	-0.2539	-3.9204***	-0.2502	-2.5843**
Trade openness (%)	-0.9923	-3.3420***	-0.3433	-2.7783**
Conflict dummy	-0.9037	-3.2811***	-0.3309	-2.6992**

Middle-income countries (LICs)				
Log (per capita GDP)	-0.2853	-2.1184**	-0.7832	-4.4873***
Military expenditure/GDP (%)	-0.5117	-2.9365***	-0.2894	-6.3894***
Log (inflation)	-0.1634	-3.3561***	-0.3792	-4.8269***
Fixed investment/GDP (%)	-0.2005	-3.5991***	-0.5984	-3.0045***
Government consumption/GDP (%)	-0.1783	-2.0390**	-0.1145	-2.8375**
Trade openness (%)	-0.2711	-3.3499***	-0.5894	-4.7593***
Conflict dummy	-0.1915	-2.1037**	-0.1063	-2.8990**

Source: Authors' compilation

Note: ** *and* *** *denotes rejection of null hypothesis at 5 and 1 percent levels, respectively*

The results of the second-generation unit root tests, as presented in Table 5, indicate that the variables are integrated of order 1 (I(1)). These outcomes reject the stationarity in levels and support the presence of stationarity in the first difference.

4.4. Panel Cointegration Tests

Given that the variables under investigation have been identified as I(1), it becomes essential to examine whether these variables are cointegrated. To achieve this objective, the study employs three tests: the Pedroni (1999; 2004), the Kao (1999), and the Westerlund (2005) tests. The results of these tests are presented in Table 6, specifically in Panels A, B, and C.

Table 6: Panel cointegration results

	Full sample		**Low-income countries (LICs)**		**Middle-income countries (MICs)**	
Panel A: Panel cointegration tests						
	Statistic	**Prob.**	**Statistic**	**Prob.**	**Statistic**	**Prob.**
Pedroni panel test (within dimension)						
Panel v-statistic	-1.9943	0.9673	-1.9973	0.9563	-1.9341	0.9264
Panel rho-statistic	-0.7139	0.8324	-0.6892	0.7450	-0.5871	0.4187
Panel PP-statistic	-12.9649	0.0000	-7.2849	0.0000	-9.8739	0.0000
Panel ADF-statistic	-9.6714	0.0000	-4.8749	0.0000	-5.5628	0.0000

Pedroni panel cointegration test (between dimension)						
Group rho-statistic	1.0973	0.8261	0.3714	0,.6281	0.7243	0.6979
Group PP-statistic	-19.8394	0.0000	-12.9842	0.0000	-15.2935	0.0000
Group ADF-statistic	-8.1147	0.0000	-4.9601	0.0000	-6.1837	0.0000
Panel B: Kao residual cointegration test						
	Full sample		**LICs**		**MICs**	
	Statistic	**p-value**	**Statistic**	**p-value**	**Statistic**	**p-value**
ADF	-7.9317	0.0000	-4.8113	0.0001	-5.0849	0.0000
Panel C: Westerlund (2005) cointegration test						
	Full sample		**LICs**		**MICs**	
	Statistic	**p-value**	**Statistic**	**p-value**	**Statistic**	**p-value**
Variance ratio	-6.7297	0.0000	-3.8911	0.0003	-4.2048	0.0001

Source: Authors' compilation

The results of the Pedroni cointegration test, presented in Table 6 (Panel A), reveal that all the variables included in the model for the full sample, as well as LICs and MICs, exhibit cointegration. This is supported by the significant values of the Panel PP-Statistic, Panel ADF-Statistic, Group PP Statistic, and Group ADF-Statistic, all at the 1 percent level.

The Panel PP-Statistic and Panel ADF-Statistic specifically show cointegration of the variables. The Group PP statistic and the Group ADF statistic show that long-term relationships remain between the country groups (LICs and MICs), even when analyzed as separate entities. This makes the results even more reliable in a range of economic situations. The findings suggest a sustained equilibrium relationship among the variables in the model. Despite short-term deviations among the variables due to shocks or other influences, they generally exhibit a tendency to move together in the long run, suggesting a stable, long-term economic relationship among them. Therefore, the results signify a stable, long-term relationship among variables across varying income levels, notwithstanding short-term variations. This is especially significant for LICs and MICs, which may encounter increased short-term instability yet can still gain from these stable long-term dynamics.

The cointegration results have several policy implications. The results indicate that MILEX policies may exert enduring effects on economic growth. While MILEX-related reforms in LICs and MICs may not yield immediate outcomes, these interrelated factors shape the long-term trajectory of their economies. For SSA countries aiming to develop more complex and diversified economies, enhancing the quality of MILEX may not yield immediate effects; however, the cointegration results indicate that it will facilitate positive structural changes over the long term.

Additionally, the Kao (1999) and Westerlund (2005) tests, reported in Panels B and C, respectively, also confirm the cointegration of the variables in both the full sample and the income groups. This is evidenced by the statistically significant ADF statistics in the Kao cointegration test and the variance ratio in the case of the Westerlund (2005) test.

4.5. Dynamic OLS (DOLS)

Once the presence of long-run relationships was confirmed, the study proceeded to estimate the long-run coefficients using the DOLS (Dynamic Ordinary Least Squares) technique, with the results presented in Table 7. This method takes into consideration endogeneity and serial correlation.

Table 7: DOLS estimation results

	Full sample		**Low-income Countries (LICs)**		**Middle-income Countries (MICs)**	
	(1)	(2)	(3)	(4)	(5)	(6)
ME/GDP (%)	-0.051*** (0.009)	-0.048** (0.018)	-0.248*** (0.025)	-0.084** (0.027)	-0.180*** (0.029)	-0.158** (0.084)
Log(INF)	-0.047** (0.018)	-0.027* (0.016)	-0.222*** (0.051)	-0.106* (0.058)	-0.147*** (0.036)	-0.078* (0.044)
FI/GDP (%)	0.177*** (0.018)	0.036** (0.013)	0.051** (0.017)	0.041* (0.022)	0.119*** (0.038)	0.082** (0.028)
GC/GDP (%)	0.061** (0.022)	0.042*** (0.008)	0.046*** (0.007)	0.022** (0.011)	0.065** (0.022)	0.025 (0.016)
TO (%)	0.052** (0.018)	0.026* (0.016)	0.073*** (0.016)	0.051 (0.038)	0.038** (0.013)	0.011* (0.006)
CONFL	-0.031** (0.012)	-0.014* (0.008)	-0.253*** (0.045)	-0.107** (0.041)	-0.171* (0.089)	-0.086* (0.047)

Diagnostic checking						
R-squared	.719	.712	.701	.700	.687	.651
Adj. R-squared	.682	.618	.694	.677	.659	.634
Robustness						
LM	3.721 (0.561)	3.609 (0.694)	3.106 (0.493)	3.052 (0.545)	4.510 (0.756)	4.327 (0.940)
RESET	2.618 (0.492)	2.558 (0.609)	3.260 (0.762)	3.119 (0.675)	4.089 (0.418)	3.942 (0.743)
WHET	4.016 (0.463)	4.007 (0.534)	4.371 (0.859)	4.175 (0.746)	5.819 (0.853)	5.371 (0.866)

Source: Authors' compilation

Note: *** and ** indicate significance at 1%, 5%, and 10% levels, respectively. LM = Lagrange multiplier test for serial correlation; RESET = misspecification test; WHET = heteroscedasticity test (White); ME/GDP denotes military expenditure/GDP; INF, inflation; FI/GDP, fixed investment/GDP; GC/GDP, government consumption/GDP; TO, trade openness; and CONFL, armed conflict. In specifications (2), (4), and (6), we control for country and year fixed effects.

From the DOLS model estimates, the coefficient of *MILEX* is negative and significant at the 1 percent level across the samples. Specifically, a 1 percent increase in military expenditure in SSA, MICs and LICs decreases growth by approximately 0.05 percent, 0.25 percent and 0.18 percent, respectively. These estimates support the findings of Okwoche (2022), Hassan et al. (2003) and, Anyanwu and Aiyedogbon (2011), but negate those of Khidmat et al. (2018) and Almajdob and Marikan (2021), among others. The results also show that the magnitude of the negative impact of *MILEX* on growth is higher in LICs compared with MICs. A plausible explanation for this that in most cases, *MILEX* is funded largely by loans in LICs. That implies that such economies borrow to fund a project that generate little or no economic returns especially in the short term. As a consequence, the overall effect of *MILEX* on growth can be negative. Mostly *MILEX* is unproductive in developing countries. Developing economies encounter numerous challenges and must prioritize efforts to foster economic growth and enhance social welfare. Once these economies attain their desired level of economic development, they may then consider allocating resources to *MILEX*. However, without exporting armaments to other countries and increasing their foreign exchange earnings, countries investing in the military may face financial losses (Azam, 2020).

Armed conflict (CONFL) adversely impacts growth regardless of the model specification and countries' income categorization. However, the

effect was more severe in LICs relatively to MICs. This is possibly caused by increased economic pressures caused by armed conflicts among countries that are already economically distressed. These findings corroborate those of previous studies (see Ogbe et al., 2024; Edokat et al., 2023; and Babajide et al., 2021).

From the DOLS model estimates, the coefficient of inflation is negative and statistically significant across the samples. Specifically, a 1 percent increase in inflation in SSA, MICs and LICs dampens economic growth by approximately 0.04 percent, 0.22 percent and 0.15 percent, respectively. These estimates support the previous findings (Ndoricimpa, 2017; Alemu & Lee, 2015; Kasidi & Mwakanemela, 2013). Both the foreign investment and government consumption variables were positively related to economic growth in the SSAs in tandem with previous studies (Topalli et al., 2021; Velonjara & Gondje-Dacka, 2019; Sabir et al., 2019; Li & Tanna, 2018). However, the impact is found to be higher in the MICs comparatively to LICs.

5. Conclusion

This study has examined the effect of *MILEX* on growth in 33 SSA countries between 2000 to 2021. The findings from this study revealed that the effect of *MILEX* depends on the income level of the economy (low- and middle- income). Generally, *MILEX* decreases economic growth in SSA, though the effect was more evident in LICs. Thus, the study highlights the significance of considering the income heterogeneity among economies when examining *MILEX*-growth relationships. From a policy perspective, our findings indicate that de-emphasizing *MILEX* in LICs can yield dual benefits: fostering economic growth and assisting these countries in achieving the Sustainable Development Goal of security.

Based on the findings, the study proposes employing military options that do not solely rely on *MILEX* to mitigate the negative growth effect of military challenges in SSA and help stimulate inter- and intra- investment opportunities. Inclusive growth policies that enhance investments especially through expanding foreign trade and foreign investment will assist in curbing the security menace in SSA. Specifically, there is urgent need to re-allocate *MILEX*. SSA countries should consider reallocating some of their *MILEX* towards productive sectors that promote economic

growth and social development. Investing in areas like education, healthcare, and infrastructure can have a positive impact on human capital and productivity. To achieve this, regional conflicts should be addressed. Given the prevalence of regional conflicts in SSA, addressing these conflicts and promoting peaceful resolutions can free up resources that could be redirected towards economic development. Regional stability is crucial for attracting foreign investment and fostering economic growth.

As captured in the government consumption-GDP variable, there is need to promote good governance. Improving governance and reducing corruption can enhance the effectiveness of *MILEX* and ensure that funds are utilized efficiently. Transparent and accountable governance can also create a conducive environment for economic growth and attract foreign investors. This requires focusing on inclusive growth. Policymakers should adopt inclusive growth strategies that target poverty reduction and social equity. Addressing income disparities and promoting inclusive economic growth can help reduce grievances that may lead to terrorism or social instability. In addition, there is urgent need to foster regional cooperation in SSA. SSA countries can benefit from increased regional cooperation in terms of security and defense. Collaborative efforts can lead to more efficient use of resources and strengthen collective security against common threats. This policy drive should be complemented by regional development initiatives. Regional development initiatives that focus on economic integration, trade, and infrastructure development can enhance SSA's overall economic growth and security environment.

By implementing these recommendations, SSA countries can strive towards a more balanced approach to military expenditure, enhancing economic growth, and achieving sustainable development in the region. It is essential to state that this study has not comprehensively appraisal specific channels in which *MILEX* affect economic growth. This will create an interesting springboard for further study in order to garner more valuable insights as regards the *MILEX*-economic growth nexus in SSA.

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