THE INFLUENCE OF OIL PRICE FLUCTUATIONS AND MACROECONOMIC CONSEQUENCES ON DEFENSE EXPENDITURE IN AFRICAN OIL-RICH COUNTRIES

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ABSTRACT

This study aims to examine the cointegration and causality between oil price fluctuations and macroeconomic consequences on military expenditure in countries that have a lot of oil resources. Heterogeneous panel estimates and data from 1980 to 2022 were included in the study. Empirical evidence suggests that real oil prices have a significant and positive impact on military expenditure in the long run, and there is a causal relationship between them. The empirical evidence shows that real oil prices have a positive impact on the long-term military expenditure in African oil-exporting countries. The SLM test revealed that the military spending of these oil-exporting nations has a U-shaped pattern, indicating that GDP plays a major role in their military spending over time. Policymakers should prioritize using oil revenues for healthcare, education, and infrastructure instead of spending excessively on defense industries. This study is aimed at bridging the knowledge gap by examining the impact of oil prices on the military budgets of these nations.

Keywords: Macroeconomic indicators; defense expenditure; African oil-rich countries; U-shape effect

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1. INTRODUCTION

The growing interdependence of culture and government across nations worldwide is a clear indication of the universal requirement for security and peace. Government military spending has been steadily increasing in several countries, particularly in Africa, with a 28% increase in 2017 compared to 2008 (Saba and Ngepah, 2020a). The spillover effects are being caused by the increasing instability and insecurity concerns in many African nations. These countries have suffered significant damage as a result of conflict and political instability. Political instability and war have caused significant harm to them. Due to the fragility of most economic activities in these countries, it is now necessary to spend more on military expenditure and extract natural resources due to the multiple conflicts occurring (Dunne et al., 2019).

The main reason for conflicts is the abundance of natural resources in different countries. The presence of internal violence is still a major concern in this region. Nigeria is a country that the Boko Haram terrorist organization has targeted. African nations place greater importance on national security and allocate more resources to it as a result. To maintain the regime and protect the nation's natural resources, military expenditures are a significant portion of government income. Erdoğan et al. (2020) suggested that security issues are particularly serious in countries that lack adequate defense technologies and solid-state traditions, or are vulnerable to significant geopolitical risks. To meet their economic responsibilities and strategies, governments need defense and security services, which are a public good (Akimov et al., 2020).

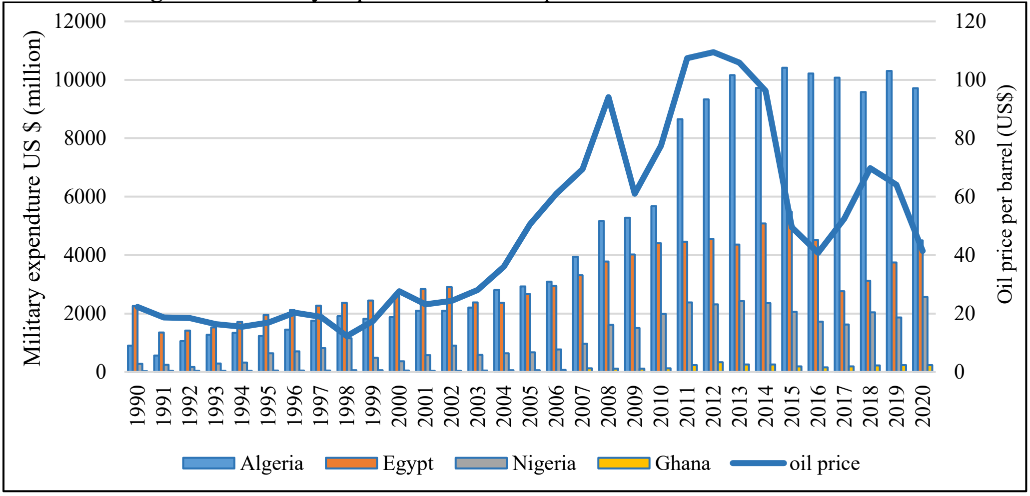
Military spending contributes to economic growth through the promotion of technological advancements that benefit all economic sectors (Deger and Sen, 1983). Numerous researchers have explored many economic aspects, including business regulations, the risk of armed conflict, poverty and inequality, unemployment, corruption, international debt, and economic growth. Prior studies have focused on the impact of military spending on economic growth. A strong consensus has not been established despite the limited number of studies on its determinants. Akpolat and Bakirtas (2020) suggest that the military's expenditure can be influenced by several factors, some of which can be measured while others are not, like the return on oil investments. The focus of current studies is overwhelmingly on military expenditures, with Abdel-Khalek et al. (2020), Raifu and Aminu (2023), Desli and Gkoulgkoutsika (2021), Phiri (2017), and Saba and Ngepah (2020b) being mostly involved in that area. The connection between oil earnings and military expenditure is crucial, as oil revenue is a significant source of national wealth in nations that export oil (Akpolat and Bakirtas, 2020).

The military expenditure trends of African countries rich in oil have undergone a significant change due to the volatility of world oil prices and constant armed conflicts throughout the continent. Africa's military spent US$39.4 billion in 2022, which is the first time the aggregated spending of the region has fallen since 2018. The expenditure dropped by 5.3% in 2021 and 6.4% in 2013 figures. North African countries were granted roughly US$19.1 billion of this spending in 2022, despite a 3.2% decrease from 2021 and a 11% increase from 2013 spending levels. Military expenditures in Africa are often high and unstable as a result of this. As previously mentioned, the increase in real oil prices has a significant impact on military spending in these economies. The SIPRI (2024) database shows that Algeria's defense budget has remained relatively stable for the past 20 years and reached an all-time high in 2015, with a total of US$10.4 billion, or 6.4% of its

GDP. Egypt's military budget has been allocated US$5.5 billion, which makes it the second largest spender because of the importance it places on maintaining a strong military presence. Nigeria has been committed to improving its military capabilities due to multiple security threats, which has resulted in an increase in military spending in recent years.

The Nigerian government allocated US$2.5 billion in 2020 to address security concerns, which is equivalent to about 6% of its GDP. According to World Bank (2024), Ghana's military expenditures jumped from US$50 million in 2000 to US$218 million in 2018 (World Bank). Despite other rich-resource nations having a larger military budget, 2020's military budget is only US$240 million, which is approximately 4% of GDP. Large military forces are present in African countries with oil wealth and require a constant supply of weapons and military equipment to remain prepared and operational. Due to changes in oil prices, the volume of military expenditure for African oil exporting countries fluctuated between 1990 and 2022, as depicted in Figure 1.

Figure 1: Military expenditure and oil prices for African oil-rich countries



Source: SIPRI (2024) and OPEC (2024).

The analysis of oil prices and their effect on military spending, particularly in oil-producing African nations such as Algeria, Egypt, Nigeria, and Ghana, has been given little attention. These countries have unique economic structures, but they share fundamental economic issues such as dependence on natural resources, poor governance, political instability, and the need for economic diversification (Alagidede et al., 2018; Eregha and Mesagan, 2020; Lawson, 2024). These countries were selected for this study due to their status as the top oil producers and exporters in Africa. Their fiscal policies and defense budgets are sensitive to fluctuations in global oil prices due to their economies' heavy dependence on revenues. Threats from groups like Boko Haram and Niger Delta militants influence Nigeria's defense expenditure (Oriola, 2021). The Egyptian military has used significant financial resources to conduct counterinsurgency operations against IS in Sinai (Maher and Zhao, 2022). The security situation in neighbouring regions like the Sahel and Libya has a significant impact on Algeria's military spending (Zoubir, 2023).

This study aims to fill a knowledge gap by investigating how oil prices affect the military spending of African nations that produce oil. The rest of this article is organized as follows: Section 2 summarizes the relevant literature; Section 3 describes the data and methodology; Section 4 assesses and examines the empirical findings; and the last section closes the research with implications for policymakers.

2. LITERATURE REVIEW

In recent years, government expenditure on defense continues to be an effective instrument for ensuring security and peace for both industrial activities and investment, spillover effects and rising insecurity and instability concerns in many African nations (Saba and Ngepah, 2020a). The SIPRI (2024) report identifies the most vulnerable governments in Africa and the world as those who spend the most on military expenditures in North Africa and Sub-Saharan Africa. Most developing nations' fragile states are often linked to their significant military expenditures. The perceived connections between global terrorism, war, and poverty have led to the prominence of country fragilities recently. The fluctuation in defense expenditure may have been caused by African nations' response to security threats. Certain regimes' aspirations to maintain their power, the emergence of regional arms conflicts, and internal and border wars and conflicts. The Lord's Resistance Army, Boko Haram, anti-Balaka, the White Army, Seleka, and Al-Shabaab are among the pirates, rebel groups, and insurgents that have become more prevalent in the region.

To boost economic growth in South Africa, Phiri (2017) recommends replacing the current excessive military expenditure with more productive non-military expenditure. Growth is promoted by military investment through the encouragement of technological advancements that are beneficial to all sectors (Deger and Sen, 1983). There are numerous ways to generate such spin-off effects. Technology that is produced for the military or utilized by businesses to meet their program standards may have clients who are not military. Similarly, although contractors may expand their capital stock and quality to fulfil military contracts, non-military manufacturing may benefit from the increased capital stock. Military spending can highlight the cutting-edge nature of military technology, which can lead to an increase in production demand and technological proficiency (Aye and Odhiambo, 2021). A beneficial externality is created by the spillover impact of defense research and the development of defense technology. Moreover, these technologies are essential for boosting industrial productivity and can be utilized in other industries.

According to a different viewpoint, military investments contribute to the development of beneficial human capital spillover (Deger and Sen, 1983). The military's personnel education and training creates human capital. By providing food, housing, and healthcare, the military contributes to a nation's human capital pool, which benefits both military personnel and their families. Suppliers may have advantages in human capital due to the possibility of transferring skills developed on military contracts to other projects. Human capital is created by the military through the education and training of its troops. Providing health care, housing, and food to members of the armed forces and their families can aid the military in contributing to a nation's human capital stock. Suppliers may benefit from the transferability of skills from military contracts to other projects in terms of human capital (Heo, 1998).

Over the past four decades, several African nations have become significant oil producers globally or regionally. The production of crude oil in Africa is more significant than its consumption. The African Petroleum Producers Association (APPO) was founded in 1987 to facilitate the sharing of information and expertise among all African oil-rich countries, demonstrating the oil market's impact on economic development in Africa (Kelikume and Muritala, 2019). It is necessary to examine the link between the abundant oil resources in the African region and military expenditure. Many previous research studies on oil prices have evaluated them in relation to market development (Jarrett et al., 2019; Gazdar et al., 2019). According to Rustamov and Adaoglu (2018), oil prices and production costs have a negative impact on economic growth in Russia. Akinsola and Odhiambo (2020) assert that the impact of oil prices on economic growth varies between countries and during periods of oil volatility. Umar et al. (2017) suggested that the economy is impacted by oil prices if investments are not made, but when investments are made, the impact on oil prices decreases. In a recent study by Babatunde et al. (2025), it was found that crude oil prices and Nigerian government expenditures have a significant positive relationship.

Africa has seen a significant rise in military spending over the past three decades, while other countries around the world have devoted significant resources to battling global terrorism (Czinkota et al., 2010). Susilo et al. (2022) discovered that military expenditures boost economic growth during the COVID-19 pandemic in developing nations. The military expenditure of Saudi Arabia and Algeria is significantly impacted by the changes in annual oil prices, as reported by Sayed et al. (2021). Abdlaziz et al. (2021) stated that an increase in oil prices resulted in a rise in defense expenses. This association is not fully supported in every market worldwide. According to Erdoğan et al. (2020), the volatility of oil prices in all GCC countries, except Bahrain, has a long-term beneficial effect on military expenditure. Akpolat and Bakirtas (2020) discovered that a few members of OPEC had diverted some of their oil revenue to pay for military expenses. Adedeji et al. (2024) examines how oil price volatility affects arms imports across OPEC member states. The results indicate that military imports are impacted by oil price fluctuations in a statistically significant and strongly negative manner.

3. METHODOLOGY

The purpose of this study is to examine how oil prices and macroeconomic indicators impact military expenditure in certain African oil-exporting regions, spanning from 1980 to 2022. Algeria, Egypt, Nigeria, and Ghana were selected due to their greater data availability than other oil-rich countries in Africa. The dependent variable for this study is military expenditure, which is calculated in millions of dollars and obtained from SIPRI (2024). The international energy market's widespread recognition of Brent crude oil price as a standard was the basis of this research. The Energy Information Administration (EIA, 2024) Database was consulted to determine the actual oil price by multiplying the nominal oil price by the GDP deflator of every country obtained from the World Bank (2024). The empirical literature was followed by using an important economic performance indicator as a control variable in this study. To measure economic growth, the World Development Indicators Database from the World Bank (2024) measured the gross domestic product (measured in constant US dollars). From the same source, the domestic credit to the private sector as a percentage of GDP was alternatively used to proxy financial development, and the total trade was measured as the sum of the imports and exports volumes. To gather data on globalization's overall state, the KOF Index of Globalization (2024) was used. Table 1 provides a description of the variables.

Table 1: Variable descriptions and data sources

Variables	Variable Descriptions	Data Source
Military expenditure (MX)	The measurement of military expenditures is done in constant US$ million.	SIPRI (2024)
Real oil price (ROIL)	The cost of an oil variety that is traded globally in US dollars divided by the GDP deflator.	EIA (2024)
Economic growth (GDP)	The US$ million values of the gross domestic product is constant	World Bank (2024)
Financial development (FD)	The private sector receives domestic credit as a percentage of GDP.	World Bank (2024)
Total trade volume (TT)	The sum of goods and services exported and imported (measured in constant USD million.	World Bank (2024)
Globalization index (GL)	The KOF index is in the range of 0 to 100.	KOF Globalization Index (2024)

The correlation between oil prices and military expenditures was examined by using the following general function.

$$MX_{it} = f(ROIL_{it}, GDP_{it}, TT_{it}, FD_{it}, GL_{it}) \tag{1}$$

where, *i*=1,2….*N* and *t*=1,2,….*T*, which indicate the individual country and the period, respectively. The study utilizes a log model to analyse how oil prices affect military expenditures.

$$MX_{it} = a_{it} + \beta_1 ROIL_{it} + \beta_2 GDP_{it} + \beta_3 TT_{it} + \beta_4 FD_{it} + B_5 GL_{it} + \varepsilon_{it} \tag{2}$$

where, the *β*'s symbolizes the estimated coefficients, ε_{it} is the random error term, and the other variables are as defined in Eq. (1). Before examining whether the data is stationary, we check for CD and slope heterogeneity among the series. As a preliminary measure, we apply the Pesaran (2004) CD test to detect the presence of cross-sectional dependence in a panel and check whether shocks in one African oil-rich nation's defense expenditures spill over to others due to shared oil revenue volatility. This test corresponds to chi-square distribution when the degrees of freedom is N(N-1)/2, under the null hypothesis of no cross-sectional dependence, with T→∞ and fixed N. When both T and N are sufficiently large, the CD test is capable of being effective. The CD test formulation is depicted in the following equation (3):

$$CD_{LM2} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^{N-1} \sum_{J=i+1}^{N} (T\widehat{p^2}_{ij} - 1)} \tag{3}$$

The cross-sectional correlation among residuals is represented by the sample estimate of $\widehat{\mathrm{p}^2}_{\mathrm{ij}}$. Where, *T* denotes time, *N* represents the number of individuals in a panel, and *i* refers to each individual ranging from 1 to *N*. In this regard, Pesaran (2004) proposed a unique test statistic that can be used when the sample size is quite large compared to the length of time. The test statistic relies on the total correlation among cross-sectional residuals.

$$CD_{test} = \sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{J=i+1}^{N}\hat{p}_{ij} \tag{4}$$

To assess the heterogeneity of cross-sectional units, the slope homogeneity test is utilized by Pesaran and Yamagata (2008). The slope heterogeneity test has the following test equations:

$$\tilde{\Delta} = (N)^{\frac{1}{2}}(2k)^{-\left(\frac{1}{2}\right)}\left(\frac{1}{2}\tilde{S} - k\right) \tag{5}$$

$$\tilde{\Delta}_{adj} = (N)^{\frac{1}{2}}\left(\frac{2k(T-k-1)}{T+1}\right)^{-\left(\frac{1}{2}\right)}\left(\frac{1}{2}\tilde{S} - 2k\right) \tag{6}$$

where, $\tilde{\Delta}$ and $\tilde{\Delta}$-adjusted are the delta tilde and adjusted delta tilde, respectively. Both intercept and slope conditions had structural breaks, and heterogeneity slope, and structural breaks were allowed by the use of the Westerlund and Edgerton (2008) test. Phillips and Sul (2003) showed that conventional cointegration methods cannot produce reliable and consistent results when applied to models with cross-sectional dependence, slope heterogeneity, and heteroskedasticity. In addition to effectively identifying potential econometric problems, the test facilitates the estimation of three distinct models: no structural break, level shift, and regime change. The optimal lag length is determined using the Campbell and Perron (1991) automatic procedure. Furthermore, this approach is appropriate for examining if there is a long-run equilibrium relationship between the study variables. The Westerlund and Edgerton (2008) cointegration test can be specified using two LM-based statistics as follows:

$$LM_{\beta}(i) = T\hat{\beta}_i\left(\frac{\hat{\delta}_i}{\hat{\sigma}_i}\right) \tag{7}$$

$$LM_{\gamma}(i) = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)} \tag{8}$$

where, $\hat{\delta}_i$ represents the least square of β_i with $\hat{\sigma}_i$ is the estimated standard error, whereas $\hat{\delta}_i^2$ shows the estimated long-term variance of the error term, and SE refers to the estimated standard error of $\hat{\beta}_i$. However, two test statistics (LM_{β} and LM_{γ}) are estimated under the assumption that there is no cointegration between the dependent and independent variables in the given model. Identifying a cointegrated relationship among the series requires examining both the direction and magnitude of this association. Conventional panel estimators are biased and inconsistent when applied to long-term relationships in the Westerlund and Edgerton framework. Pesaran et al. (1999) suggested a pooled mean group (PMG) methodology as a powerful estimator for cointegrated panels to address this limitation. An error-correction term is used in this method to provide the long- and short-run elastic coefficients for a heterogeneous panel. Jahanger et al. (2022) stated that the long-run coefficient should be uniform, and the PMG estimator agrees. Moreover, the intercept, error variance, and short-run coefficient can fluctuate depending on the country. The PMG model employed in this study for panel estimations is described in equation (9).

$$MX_{it} = \sum_{j=1}^{q} \partial_{ij}\Delta MX_{i,t-j} + \sum_{j=1}^{q} \beta'_{ij}\Delta ROIL_{i,t-j} + \sum_{j=1}^{q} \varrho'_{ij}\Delta GDP_{i,t-j} + \sum_{j=1}^{q} \Theta'_{ij}\Delta FD_{i,t-j} + \sum_{j=1}^{q} \Phi'_{ij}\Delta TT_{i,t-j} + \sum_{j=1}^{q} \varphi'_{ij}\Delta GL_{i,t-j} + \mu_i + \varepsilon_{it} \tag{9}$$

where, MX_{it} represents the military expenditure of specific countries i during the time of the t dimension. While, $ROIL_{it}$ indicates real oil price, GDP_{it} is the gross domestic product as a proxy of economic growth, FD_{it} is financial development, TT_{it} is total trade volume, and GL_{it} refers to the globalization index. The term ∂_{ij} shows the scalars, β_{ij}, ϱ'_{ij}, Θ'_{ij}, Φ'_{ij}, and φ'_{ij} are the coefficient vectors of independent variables, and q is the lag length, and ε_{it} is known as a residual term. The adjustment speed of the related parameter can be presented in the following way:

$$\Delta p_{it} = \left(\delta p_{i,t-1} + \pi_i X_{i,t}\right) \sum_{j=1}^{q-1} \partial_{it}\delta\Delta p_{i,t-j} + \sum_{j=0}^{q-1} \beta_{ij}\Delta X_{i,t-j} + \mu_i + \epsilon_{it} \tag{10}$$

where, p_{it} is the dependent variable represented by MX_{it}, and $X_{i,t}$ is a vector representing the independent variables, δ_i term embodies the coefficient of speed adjustment term, it should be statistically significant and has a negative sign. While the equation $\left(\delta p_{i,t-1} + \pi_i X_{i,t}\right)$ indicate the error correction term that shows the long-run model. While the equation $(\sum_{j=1}^{q-1} \partial_{it}\delta\Delta p_{i,t-j} + \sum_{j=0}^{q-1} \beta_{ij}\Delta X_{i,t-j} + \mu_i)$ for the short-term model. Both short- and long-term relationships are covered by the PMG model in the following way:

$$\delta MX_{it} = \delta_i\left(MX_{i,t-1} - \pi_{1i}ROIL_{i,t} - \pi_{2i}GDP_{i,t} - \pi_{2i}FD_{i,t} - \pi_{3i}TT_{i,t} - \pi_{4i}GL_{i,t}\right) + \sum_{j=1}^{q-1} \partial_{it}\delta\Delta MX_{i,t-j} + \sum_{j=0}^{q-1} \beta_{ij}\Delta ROIL_{i,t-j} + \sum_{j=0}^{q-1} \varrho_{ij}\Delta GDP_{i,t-j} + \sum_{j=0}^{q-1} \Theta_{ij}\Delta FD_{i,t-j} + \sum_{j=0}^{q-1} \Phi_{ij}\Delta TT_{i,t-j} + \sum_{j=0}^{q-1} \varphi_{ij}\Delta GL_{i,t-j} + \mu_i + \epsilon_{it} \tag{11}$$

To summarize the dependent and independent variables in the following equation, a model form is utilized.

$$\Delta MX_{it} = a_{1j} + \sum_{j=1}^{q} \partial_{ij}\Delta MX_{i,t-j} + \sum_{j=1}^{q} \beta'_{ij}\Delta ROIL_{i,t-j} + \sum_{j=1}^{q} \varrho'_{ij}\Delta GDP_{i,t-j} + \sum_{j=1}^{q} \Theta'_{ij}\Delta FD_{i,t-j} + \sum_{j=1}^{q} \Phi'_{ij}\Delta TT_{i,t-j} + \sum_{j=1}^{q} \varphi'_{ij}\Delta GL_{i,t-j} + \pi_i ECT_{i,t-1} + \varepsilon_{it} \quad (12)$$

To establish causal linkages, the Dumitrescu and Hurlin (DH) (2012) test was utilized. To improve the efficiency of the DH causality test in a panel context, it is necessary to address cross-sectional dependence problems in panel data (Dogan and Seker, 2016). The DH causality model can be derived by completing the following steps.

$$MX_{i,t} = \alpha_i + \sum_{k=1}^{n} \partial_i^{(n)} MX_{i,t-n} + \sum_{k=1}^{n} \gamma_i^{(n)} ROIL_{i,t-n} + \sum_{k=1}^{n} \varphi_i^{(n)} GDP_{i,t-n} + \sum_{k=1}^{n} \emptyset_i^{(n)} FD_{i,t-n} + \sum_{k=1}^{n} ß_i^{(n)}\, TT_{i,t-n} + \sum_{k=1}^{n} 6_i^{(n)}\, GL_{i,t-n} + \epsilon_{i,t} \quad (13)$$

where, α_i represents individual effects that are assumed to be fixed in the time dimension. $\partial_i^{(n)}$is lag parameters $\gamma_i^{(n)}$, $\varphi_i^{(n)}, \emptyset_i^{(n)}, ß_i^{(n)}$, and $6_i^{(n)}$ denote lag the autoregressive parameters that differ across groups, respectively. Thus, hypotheses about the causality of DH are labelled as follows:

$$H_0: \partial_i, \gamma_i, \varphi_i, \emptyset_i, ß_i, 6_i = 0 \quad , \quad \forall i = 1, \dots, N$$
$$H_1: \partial_i, \gamma_i, \varphi_i, \emptyset_i, ß_i, 6_i = 0 \quad , \quad \forall i = 1, \dots, N_1$$
$$\partial_i, \gamma_i, \varphi_i, \emptyset_i, ß_i, 6_i \neq 0 \quad , \quad \forall i = N_1 + 1, N_1 + 2 \dots, N \quad (14)$$

According to the null hypothesis, the panel is not a causal factor and produces an outcome that is homogenous. According to the alternative hypothesis, a causal relationship exists in at least one cross-section unit. The null hypothesis will be rejected if the estimated probability values are below the significance level. Conversely, we cannot be sure of rejecting the null hypothesis. The DH panel causality test computed the Wald statistic for each cross-section unit independently to calculate the test statistic. The panel's Wald test statistic was obtained by aggregating the results of each test statistic. The panel test statistic can be determined by the following method:

$$W_{N,T}^{Hnc} = \frac{1}{N} \sum_{i=1}^{N} W_{i,t} \quad (15)$$

The Lind and Mehlum (2010) technique, also known as the Sasabuchi-Lind-Mehlum (SLM) technique, was chosen for the purpose of capturing the quadratic relationships between GDP performance and military expenditure in this study. The capability of this technique lies in presenting SLM statistics and visualizing the complete curve of the data interval. The estimator equation for the SLM test in this study was created by utilizing the following:

$$MX_{it} = \alpha GDP_{it} + \beta GDP_{it}^2 + \gamma V_{it} \quad (16)$$

where, involving MX and GDP, can be summarized as follows:

$$H_0: (\alpha + \beta 2GDP_{min} \leq 0) \cup (\alpha + \beta 2GDP_{max} \geq 0) \quad (17)$$

$$H_1: (\alpha + \beta 2GDP_{min} > 0) \cup (\alpha + \beta 2GDP_{max} < 0) \quad (18)$$

GDP_{min} and GDP_{max} are the minimum and maximum value stages of the GDP series for all countries in this study. The presence of a U-shaped relationship between military expenditure and the quadratic coefficients of the GDP series can be determined by rejecting the null hypothesis by the SLM test statistics. The increase in military expenditure over time will be a result of the improvement in GDP performance.

4. RESULTS AND DISCUSSION

Table 2 exhibits the descriptive statistics of the variables and the correlation coefficient matrix. Evidence shows that the mean and median of GDP and total trade are higher than military expenditure, real oil prices, globalization, and financial development. Due to the unexpected increases and decreases in 2008 and 2014, the standard deviation of real oil prices is the highest among other variables. Due to a long right tail, the skewness value of oil prices will be positively skewed. Unlike other variables with a flat surface, the kurtosis value for oil prices is leptokuric because of a peak in the normal distribution curve. The distribution of the variables studied was established by using the Shapiro-Wilk (SW) (1965) and Shapiro-Francia (SF) (1972) tests. The normality test results show that all variables reject the null hypothesis at 5 and 10% levels and do not have a normal distribution condition.

Table 2: Descriptive statistics

	MX	ROIL	GDP	TT	FD	GL
Mean	6.741	0.905	25.299	23.995	2.646	3.897
Maximum	9.250	7.755	26.943	26.097	4.238	4.225
Minimum	3.119	-1.771	22.933	19.357	0.433	3.519
Skewness	-0.605	1.445	-0.638	-0.976	-0.089	-0.200
Kurtosis	2.306	5.372	2.674	4.091	2.520	2.045
SW-statistic	4.618*	5.365*	5.044*	5.054*	2.460*	4.036*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)
SF-statistic	4.542*	5.689*	4.172*	4.620*	1.542***	3.015*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.061)	(0.001)

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10.

The cross-sectional dependence test results confirm that CD test effects are present in the data for this study, but not FD. It reveals that the cross-sections of financial development are not interdependent across countries signifying that the impact of shocks on financial systems in oil-rich countries can vary depending on several factors, including the size and diversity of the economy, the level of government intervention in the economy, and the strength of the financial sector. As a result, it backs up the idea that the economic data of one region can have an impact on the economic data of another. There is evidence that there is a CD condition in the regions of these countries. In the slope homogeneity test performed by Persaran and Yamagata (2008), the null hypothesis is rejected at a 5 percent significant level, indicating that the slope of coefficients is caused by a heterogeneous condition, as demonstrated in Table 3.

Table 3: Cross-sectional dependence and homogeneity tests

Variables	Pesaran's CD test	
	CD Statistics	**p-value**
MX	9.488*	0.000
OIL	5.836*	0.000
GDP	15.288*	0.000
TT	14.066*	0.000
FD	-0.067	0.946
GL	14.731*	0.000
Pesaran-Yamagata homogeneity test		
$\tilde{\Delta}$	2.800**	0.023
$\tilde{\Delta}$-adjusted	2.788**	0.034

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10.

Due to homogeneity concerns, Herwartz and Siedenburg (2008) proposed second-generation panel unit root tests for this study. The null hypothesis of non-stationarity of the series of interests is used by this approach to address issues related to heterogeneity and cross-sectional dependence in panel data. The panel tests for the unit root include the unit root test at level and the first difference. Low test statistics for all series indicate that the panel is not stationary at this level. The first difference dataset was measured, and we found strong evidence that all series are stationary. Non-stationarity at first difference cannot be disproved except for GDP.

Table 4: Herwartz and Siedenburg heterogeneous panel unit root test results

Variables	At level		At first difference	
	Constant	**Constant and Trend**	**Constant**	**Constant and Trend**
MX	-0.728	0.182	-0.224**	-0.577***
ROIL	2.466	1.462	-2.760*	-2.394*
GDP	1.426	-0.132	-1.287***	-2.017**
TT	0.647	0.027	-2.343*	-1.954**
FD	-0.593	4.862	-1.770**	-1.091
GL	-0.530	1.734	-2.655*	--1.719**

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10.

According to the test statistics of Westerlund and Edgerton (2008), the no break and level break models cannot reject the null of no cointegration in the no break and level break models. Significant evidence of long-run cointegration in African oil-producing countries was uncovered by regime shifts in the cointegration equation. The regime shift model was used to examine these results, which confirms the findings of Erdoğan et al. (2019) regarding BRICS-T countries.

Table 5: Westerlund and Edgerton (2008) cointegration test results

Estimation Models	$Z_\tau(N)$	$Z_\emptyset(N)$
No shift	-0.225	-0.242
	(0.411)	(0.404)
Level shift	-0.712	-0.762
	(0.238)	(0.223)
Regime shift	-1.935***	-1.367***
	(0.075)	(0.086)

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10. $Z_\tau(N)$ and $Z_\emptyset(N)$represent the test statistics. The lag length is decided by the method proposed by Campbell and Perron (1991).

The relationship between long-run and short-run PMG estimates is illustrated by the PMG equation. Military expenditures in African oil exporting regions experience a statistically significant impact factor of 0.559 when oil prices hit 1%. The increase in oil prices has a positive and statistically significant effect on military expenditures in African oil-producing countries. Several African countries are still facing threats from terrorist groups affiliated with AQIM (also known as Da'esh), Boko Haram's terrorist activities, and foreign terrorist fighters. In the African context, there are two primary reasons that make terrorism more likely and appealing: (1) the continent is rich in natural resources, (2) secondly, terrorism or conflicts tend to arise in areas where the wealth generated from these resources is not equitably shared (Fletcher et al., 2022). Erdoğan et al. (2020) found that oil price fluctuation has a significant impact on military expenditure in all GCC nations, which is consistent with their findings.

The findings from Do (2021) highlight the positive effect of oil rents on military spending in 163 economies, and the relationship between GDP and military expenditure is significant. An increase in defense expenditures is due to economic growth in oil-producing African countries. This is consistent with Oman`s case, where Erdoğan et al. (2020) explored the increases in military spending associated with economic growth, while the former is negatively influenced by GDP growth in the case of Kuwait, Bahrain, and Saudi Arabia. Military expenditure is affected by the financial development of the financial sector. The development of the financial sector implies that borrowers will have more access to domestic credit. With this access, they can borrow more easily and at more favorable rates, which enables them to finance greater military expenses.

In the long term, military expenditure is not connected to globalization and trade. It appears that the money generated by trade and globalization is being diverted to other expenses rather than being mainly allocated to military expenses. Koyuncu and Okşak (2022) claimed that trade plays a positive role in Turkey's military expenditure, but their findings are conflicting. The short-term findings indicate that defense expenditures in oil-rich countries in Africa are positively linked to only total trade. African oil-rich countries experience a gradual correction of 0.347% per year due to the negative and statistically significant error correction term. The variables tested in the PMG estimator have a stable long-term relationship, as evidenced by empirical evidence.

$$MX = -14.372 + 0.559ROIL + 1.645GDP + 0.130TT - 0.455FD + 0.747GL - 0.072\Delta ROIL$$

(0.093)* (0.913)*** (0.202) (0.108)* (0.544) (0.059)

$$+ 0.640\Delta GDP - 0.090\Delta TT + 0.127\Delta FD - 0.253\Delta GL - 0.347ECT_{t-1}$$
$$(0.563) \quad (0.020)^* \quad (0.226) \quad (0.339) \quad (0.113)^*$$

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10.

Table 6 presents the summary results of the heterogeneous panel DH causality test. The rejection of the null hypothesis that the oil price is not the cause of military expenditure indicates a one-way causality between the actual oil price and military expenditure. This happens because higher oil prices result in increased revenue, and governments prefer to allocate a portion of these funds to support their military budgets. The conclusion is agreed upon by Sayed et al. (2021) and Akpolat and Bakirtas (2020). The causality between economic growth and military expenditure was depicted equally. Abdel-Khalek et al. (2019) found inconsistencies in the results on India, while Khan et al. (2020) found inconsistencies in the results on G-7 countries. The findings indicate that the causality of total trade, globalization, and military expenditure is unidirectional. The empirical analysis in a bivariate case suggests that financial development and military expenditure have a feedback connection. This outcome implies that military expenditure in oil-rich African countries is correlated with their financial development, such that an increase in financial sector development will spark an increase in military expenditure in these countries, and vice versa. The findings of Gokmenoglu et al. (2021) conflict with these findings.

Table 6: DH heterogeneous causality test results

Null hypothesis	W-statistics	p-values	Conclusion
ΔROIL ─ /→ ΔMX	4.763**	0.019	Unidirectional
ΔMX ←/─ ΔROIL	2.160	0.975	
ΔGDP ─ /→ ΔMX	10.091*	0.000	Unidirectional
ΔMX ←/─ ΔGDP	3.507	0.221	
ΔFD ─/→ ΔMX	7.978*	0.000	Bidirectional
ΔMX ←/─ ΔFD	8.656*	0.000	
ΔGL ─/→ ΔMX	12.669*	0.000	Unidirectional
ΔMX ←/─ ΔGL	1.493	0.576	
ΔTT ─/→ ΔMX	9.782*	0.000	Unidirectional
ΔMX ←/─ ΔTT	1.376	0.508	
ΔTT ─/→ ΔGDP	6.792*	0.000	Unidirectional
ΔGDP ←/─ ΔTT	2.074	0.192	
ΔTT ─/→ ΔFD	4.747*	0.000	Unidirectional
ΔFD ←/─ ΔTT	2.127	0.170	
ΔGL ─/→ ΔTT	6.406*	0.000	Unidirectional
ΔTT ←/─ ΔGL	0.253	0.303	
ΔROIL ─ /→ ΔGDP	2.502	0.061	Unidirectional
ΔGDP←/─ ΔROIL	8.074*	0.000	
ΔFD ─/→ ΔROIL	2.243	0.128	Unidirectional
ΔROIL ←/─ ΔFD	4.184*	0.000	
ΔTT ─/→ ΔROIL	1.579	0.503	Unidirectional
ΔROIL ←/─ ΔTT	4.801*	0.000	
ΔGL ─/→ ΔROIL	0.469	0.451	No Causality
ΔROIL ←/─ ΔGL	1.738	0.382	
ΔFD ─/→ ΔGDP	2.088	0.186	Unidirectional
ΔGDP ←/─ ΔFD	4.051*	0.000	

ΔGL ─/→ ΔGDP	5.500*	0.000	Unidirectional
ΔGDP ←/─ ΔGL	0.261	0.192	
ΔGL ─/→ ΔFD	4.113*	0.000	Unidirectional
ΔFD ←/─ ΔGL	2.442	0.076	

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10.

The results of the SLM U test for African oil-exporting countries are presented in Table 7. At the lower boundary of GDP, there is a significant negative trend in the slope coefficient and a positive trend at the upper boundary. However, the lower bound slope of GDP in Egypt and Nigeria appears to be negative (-0.255) and negative (-0.905), respectively. However, the slopes are statistically insignificant, which indicates that the null hypothesis of no inverted U-shape cannot be rejected against the alternative hypothesis of an inverted U-shaped relationship between military expenditure and the minimum value of GDP. These findings point out that the stability and security of the military may not be affected by economic growth at low levels of GDP, leading to a decrease in military spending. According to Umar and Abu (2016) and Dimitraki and Emmanouilidis (2024), Nigeria's military spending is most likely driven by security threats rather than proactive economic strategies. While the Egyptian defense sector derives its funding from multiple sources, including: (1) state budgetary allocations tied to foreign debt servicing obligations, (2) annual U.S. military assistance packages, (3) financial support from GCC states following the 2014 political transition, and (4) off-budget revenues generated through military-operated commercial enterprises (Kuimova, 2020). The U-shaped relationship exists as confirmed by the SLM test results, which show that the null hypothesis is not rejected by the four African oil-exporting countries.

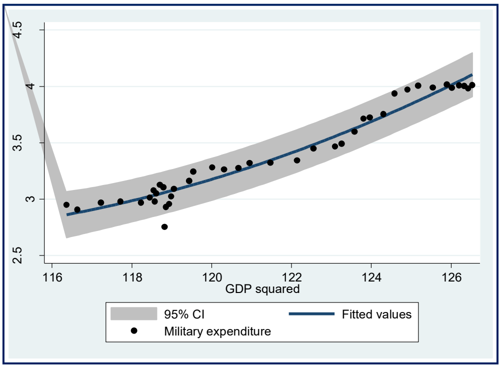
It's obvious that these countries rely heavily on GDP performance and gradually increase their military budget over time. According to Dimitraki and Emmanouilidis (2024) study, low military expenditure has negatively impacted GDP growth in Nigeria. The productivity, innovation, and economic growth of the most militarized countries are impacted in a long-term way by military expenditure, as stated by Inal et al. (2024). The SLM null hypothesis is contradicted by the fact that every African country that exports oil has a U-shape condition, as shown by the U-shape fitting curve in Figure 2.

Table 7: SLM U-shape test estimates

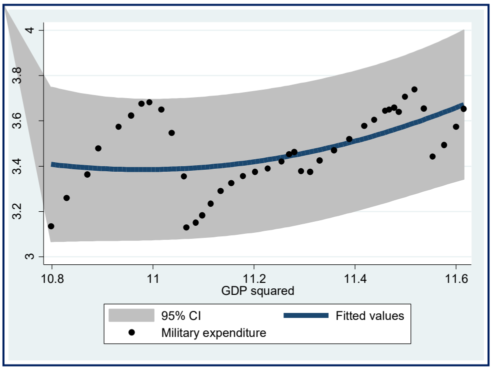
	Algeria	**Egypt**	**Ghana**	**Nigeria**
Slope at GDP_{min}	1.384*	-0.255	-1.173*	-0.905
	[3.019]	[-0.621]	[-2.488]	[-0.992]
Slope at GDP_{max}	3.983*	0.902**	2.932*	2.740*
	[9.983]	[2.381]	[6.215]	[3.245]
SLM statistics	1.020	0.620	1.190	0.990
	(0.112)	(0.269)	(0.186)	(0.164)
Hypothesis decision	∪ shape	∪ shape	∪ shape	∪ shape

Notes: *p< 0.01, **p< 0.05 and ***p< 0.10. Values in [ ] and ( ) represent t-statistics and p-values, respectively.

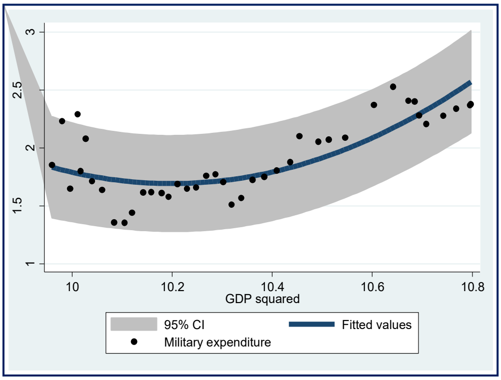
Figure 2: The U-shape relationship between GDP and military expenditure



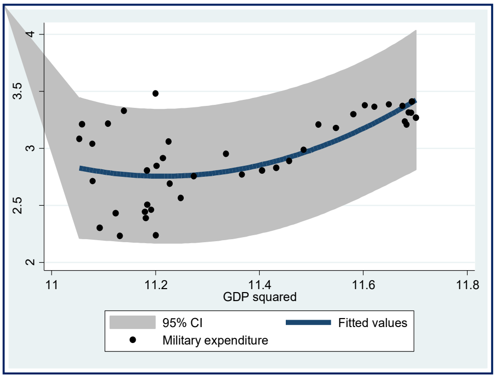
(a) Algeria



(b) Egypt



(c) Ghana



(d) Nigeria

5. CONCLUSION

Numerous empirical studies have investigated how oil prices affect African economies. The correlation between oil prices and military spending has not been studied much. The increase in oil prices is a major factor in supporting defense spending in the countries under consideration, as evidenced by empirical evidence. The increase in military spending is a result of economic growth, and the relationship between financial development and military expenditures is inverse. There was no statistical significance to the positive impact of total trade and globalization on defense expenditures. Short-term military spending isn't influenced by any variables, except for total trade, which has a significant negative impact. The DH causality test indicates that oil prices, economic growth, total trade, financial development, and military expenditures are all directly connected.

Oil-producing countries' revenue can be greatly impacted by higher oil prices and growth. A probable reason could be that they are geographically close to the threats; for example, Algeria increased its military spending to keep up with the state's need to combat terrorist groups during the civil war from 1990 to 2002. Libya, Tunisia, and Egypt witnessed and later spread Arab Spring protests throughout the region. To address various security issues, such as Boko Haram's insurgency in the northern part of the country and unrest in the Niger Delta. These reasons have led Nigeria to increase its military spending in recent years. The history of contemporary Egypt has been marked by frequent political violence between successive governments and radical Islamic groups, with riots starting in the 1980s and continuing until recently. The government increased its military budget in response to this. As for Ghana, disturbances in neighbouring regions, such as the civil war in Côte d'Ivoire, refugees, and border incursions, presented significant challenges to committees established within the armed forces.

When estimating future oil prices, it's crucial to consider the impact of crude oil prices on African oil-producing countries. Due to the strong link between oil prices and military expenditures in these countries, their defense budgets could be unstable due to fluctuation in oil prices. The limited impact of oil revenues on welfare enhancement is the cause of the economic inefficiency and resource waste associated with meeting military requirements. The political stability of every oil-rich African nation and the terrorist threat and conflicts it faces determine the relationship between crude oil prices and military spending. The influence of these factors on the relationship between crude oil and military spending can be investigated through subsequent research. In order to determine whether the majority of income is spent on defense or public welfare programs, it is important to conduct further research into oil-exporting countries to examine the components of government spending. In order to improve the representativeness and reliability of the outcomes, future studies need to expand the scope and quality of data used. Building resilience against terrorism and extremist ideologies can help societies create a more secure environment without solely relying on military solutions.

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