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The Optimal Orchestration of Military Expenditure for Economic Growth in Africa: A Non-Linear Threshold and Regional Heterogeneity Analysis

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ABSTRACT

This study presents an extensive empirical investigation into the non-linear relationship between military spending and economic growth, backed by data from 45 African countries for the period of 1990-2023. We relied on an extended Solow growth model and a multi-method econometric approach consisting of System GMM, Panel ARDL, and Panel Threshold Regression; to deal with the problems of endogeneity, dynamic panel bias, and heterogeneity. The results of the analysis confirm in a robust manner the non-linear Inverted U-shaped relationship, with the growth-maximizing military spending threshold endogenously determined by the panel threshold regression at around 2.4% of GDP. It merits consideration that the coefficient of this threshold is yielded by a static PTR model, which constitutes a methodological constraint as it does not integrate the serial dependence in growth data fully. The correlation is marked by considerable regional heterogeneity; North Africa has a higher threshold of 3.2% of Gross Domestic Product (GDP) while the conflict areas (e.g., the Sahel) are experiencing economic losses. However, above all, the caliber of institutions is recognized to be the main factor moderating the situation where better governance amplifies the growth returns of military spending through the mechanisms of efficiency and accountability. At the same time, the findings also reveal a significant temporal trade-off: the immediate interaction of security and higher aggregate demand is slowly superseded by the long-term crowding-out effect on human and physical capital accumulation. The projections demonstrate that the period of investment in education and governance reforms may not be mandatory before the associated prosperity dividends become sizeable if such a policy approach is complemented by the reallocation of financial resources from military spending cuts to the mentioned areas. Thus, it is evident that context-specific fiscal rules within the frame of institutional reinforcement and regional security cooperation are the ultimate pre-requisite for Africa to tap into the potential of the security-growth nexus amidst its poly-crisis situation.

Keywords: Military Expenditure, Economic Growth, Africa, Institutional Quality, Threshold Analysis, Fiscal Policy, Regional Heterogeneity.
JEL Codes: H56; O55; C33.

INTRODUCTION

The interplay between security expenditures and economic growth remains a complex and multifaceted challenge that scholars will continue to investigate. However, this nexus is paramount for Africa. It encompasses not only the state fiscal allocation but also the competition for the mechanisms of governance that imply economic value and political influence simultaneously (Acemoglu & Robinson, 2012). Therefore, military outlays could be viewed as an allocation on "stability resources", which may then furnish the communal benefit, the actual foundation for fiscal activities.

Conceptual paradigms suggest that it can, through these avenues, amplify aggregate demand by the demand-side dynamics (Dunne and Uye, 2010) and thus forge a reliable setting that lures both domestic and international equity placements (Benoit, 1978) and, under specific stipulations, might even trigger substantial technology diffusion. In addition, in a circumstance where the legitimacy of state authority is routinely confronted, the armed forces become the principal apparatus of the nation in maintaining its sole control over the lawful deployment of coercion, which Tilly (1985) identifies as a core characteristic of a contemporary state. On the other hand, for the less financially advanced nations in Africa, the forgone advantage is so significant that it results into a monetary contraction.

The intermittent state financing which is, intrinsically, apportioned to the armed forces is commonly extracted from the segments that would generate the optimal yields in personnel capital (pedagogy and wellness), power and transport, and societal prosperity (Knight, Loayza & Villanueva, 1996).

The outcome would be a circumstance where the military and security outlays of the regimes would be so elevated that their debts would be equivalent or even exceed the military and security outlays. Consequently, if the authorities would escalate the loan premium to settle the debts, the ramification would be the non-governmental domain being displaced from the economy either through steep nominal charges or apprehension of prospective levies, while at the same time disregarding the sectors that foster the extended, enduring economic advancement (Deger & Smith, 1983).

Investigation Context

The global empirical information accessible in the publications show a significant theoretical ambiguity because the correlation between security outlays and fiscal outcomes is still a contested subject. The findings obtained from this academic inquiry are frequently greatly dependent on the econometric modeling applied, the specific national jurisdictions selected, and the macro-institutional environment where the research is conducted. Conversely, present-day Africa is depicted as a continent that is experiencing a very clear trend of escalating and diversifying stability threats.

The risks are not only heterogeneous but also include, among other things, the long-term and persistent geopolitical conflicts in key regions such as the Sahel and the Horn of Africa, raising apprehensions about maritime security in the Bight of Biafra, which is one of the most critical determinants. Therefore, the intricate and evolving security landscape has pioneered a new venue of inquiry on the monetary and tangible repercussions of the augmented military demands with the aid of an investigative sophistication that is superior to what has been executed previously.

Current data suggests a pattern of volatility in aggregate defense investment by African states although it has been consistently ascending since the commencement of the past ten-year period. The specific macroeconomic repercussions of this elevated expenditure are still a point of vigorous scholarly debates.

Literature Deficiencies and Inquiry Hypotheses

The preceding scholarly investigations on Africa has yielded substantial comprehension but at the same time uncovered some chief methodological and conceptual limitations. A dominant segment of the inquiry executed utilized obsolete stationary econometric paradigms (such as OLS or Permanent Ramifications) that do not even approach to mitigating the perpetual endogeneity dilemma between financial advancement and security outlays (Ali, 2012).

Moreover, some analyses do not address whatsoever the crucial interceding functions of the standard of administration and the severity of the hostilities and succumb to the error of territorial homogeneity, thus rendering it impracticable to examine the predicament for the vast and material discrepancies among African states concerning the security, fiscal, and political dimensions (Bove, Elia, & Smith, 2017; Saba & Ngepah, 2019).

Aims and Queries Pertaining Therefore

This document incisively and exhaustively evaluates the complexities of the inquiry. The investigation relies on a data repository which has never been scrutinized previously, and that spans a 45-year duration from 1990 to

2023 encompassing 45 states in Africa. The scholars have circumvented the former methodological limitations by utilizing a hybrid econometric framework that is the linchpin of the analysis.

The System Generalized Methodology of Moments not only resolves the endogeneity dilemma but also the unobserved country-specific determinants. The Panel Autoregressive Segmented Lag paradigms explicitly demonstrate the specification of proximal dynamics and extended Equilibrium Stipulations. The Panel Threshold Regression algorithm permits the extraction of the magnitudes of expenditure that have been established statistically as optimum.

Academic Contribution Afforded

The temporal assessments of administrative standard derived from the composite metric of the Global Regime Indices and the strife severity information from the Uppsala Adversity Data Initiative are designated as the principal mitigating determinants in the inquiry's methodology which is constructed around a cohesive analytical model.

Nevertheless, we emphasize that the application of the Panel Threshold Regressionalgorithm in our evaluation rests on a stationary structure disregarding the persistence of financial advancement, which has to be cited as a substantial constraint of our framework that impacts the interpretation of our operational endorsements.

Thesis Structure Presentation

One of the main architectural features of the document is the application of a conceptual framework that adopts a cohesive and systematic progression through the interconnected variables. The next section offers a mixed and schematic scholarly assessment that explains the main directions of conceptual development while including the quantitative research conducted in both the global and African jurisdictions. The third unit not only presents a solid theoretical foundation but also a detailed modeling structure, a rigorous empirical assessment, and validation metrics. The fourth division reveals a complex visualization of the empirical results that also contains robustness checks and future forecasts. Finally, unit five turns fine distinctions into operational, area-specific legal recommendations and a detailed policy synthesis is given.

LITERATURE REVIEW

Theoretical Foundations: Competing Paradigms

The theoretical landscape is mainly characterized by three rival conceptual frameworks that foretell different economic consequences of defense spending. The Expansion Hypothesis, which is primarily represented by the seminal work of Benoit (1978), argues that military expenditure is a positive determinant for economic advancement.

This perspective claims that military spending can accelerate economic activity by increasing government aggregate demand, foster human resources through vocational training and skill development, and promote the spillover of new technologies that can be used for civilian purposes (technological diffusion), and most importantly, grant the stability and security apparatus needed for inward productive investment to thrive (Dunne & Uye, 2010; Pieroni, d'Agostino, & Lorusso, 2019.

Deger and Smith (1983) themselves proposed that the burden hypothesis is in direct antithesis with the expansion hypothesis.. This viewpoint asserts that defense spending is an economic growth hindrance. The main reason behind the negative economic impact of military expenditure is the diversion of investment away from infrastructural and human capital (education and health) to less productive military activity due to the limited resource allocation (Knight, Loayza, & Villanueva, 1996).

Moreover, the tendency of such expenditure to create inflationary pressures, escalate public debt, and, potentially, instigate arms races that turn the region into a powder keg and force expenditure beyond the optimal level further strengthens military spending's negative impact (Smith, 2017).

The non-linear hypothesis, synthesizing these extremes, disavows the monotonicity assumption. The important paper of Brumm (1997) and later improvements by Yildirim, Sezgin, and Öcal (2005) assert the existence of a Inverted U-shaped curve, similar to a "defense Laffer curve."

This intricate model acknowledges that defense expenditures of up to such levels as to cover the country's needs could still have positive effects on the economy in terms of growth (e.g., through security provision and demand stimulation), but it asserts that after a country-specific optimum is reached, the negative crowding-out effects from excessive defense spending will begin to prevail, thus, causing a reverse in economic growth (Chen, Lee, & Chiu, 2014; Hou & Chen, 2013)..

Global Empirical Evidence: A Mosaic of Results

Theoretical disputes are confirmed by global empirical research. Their outcomes are strongly correlated with the methodology, the time frame, and the sample selection. The first studies conducted across countries were trailblazing but often not very sophisticated in their methods. Positive finding of Benoit (1978) was opposed by Lim (1983) and Deger (1986) who found negative effects and pointed out investment crowding-out channel, respectively. Building up of panel data techniques and advanced econometrics made the whole affair so much clearer.

For example, Dunne and Nikolaidou (2001) i.e. found good effects concerning developed countries but negative or not very significant ones in case of LDCs. Meta-analysis of 69 studies by Alptekin and Levine (2012) gave a rather pessimistic picture of the average effect which usually is small, negative, and critically dependent on the context.

Models were the critical advances that more credibly dealt with endogeneity and their introduction was a breakthrough. By using System GMM, Bove, Elia, and Smith (2017) proved that military spending had positive or negative impacts depending on the institution's quality in the country concerned.

Likewise, d'Agostino, Dunne, and Pieroni (2019) revealed that overlooking conflict and corruption factors leads to grossly incorrect outcomes. Not only that, but there is also very strong and growing empirical support for the non-linear model.

Research varied between different samples taken to find out optimum thresholds. Yildirim et al. (2005) established a threshold for countries in the Middle East equal to 3.1% of GDP while Chen et al. (2014) indicated a lower threshold for one group of OECD nations.

African Context: (Heterogeneity, Conflict, and Institutional Fragility)

The African scenario was particularly complex; the research conducted reflected the vast differences in income levels of the continent, institutional capacity, and how much the countries had been affected by conflicts. Usually, full-panel studies give inaccurate or conflicting results, thus obscuring the critical underlying heterogeneities.

Aikaeli and Mlamka (2010) discovered an overall negative correlation when they conducted a cross-sectional study of 48 countries. On the contrary, Ali (2012) argued that a slightly positive effect could be seen in stable African states, and he stressed the importance of the security environment background.

The impact of the institutions and governance has been more and more accepted as a necessary intermediary factor. The empirical studies imply that the economic results of military spending are not the same all over Africa and they commonly bear a relationship with the stability of the state.

In particular, the findings show a strong connection between the state's instability and the adverse effect of military budget as the poorest countries are claimed to be facing the hardest times. Studies conducted in conflict-affected areas have suggested that heavy militarization at all times is a primary obstacle to the economic recovery and growth of these areas.

Geographical studies reveal this diversity very clearly. The research focused on the economies of North Africa, for instance, usually results in neutral or slightly positive outcomes. The situation is frequently associated with larger and more sophisticated industrial sectors in these nations and varied geopolitical pressures.

Conversely, research involving conflict areas, such as the Sahel and East Africa, provides solid evidence of enormous negative effects on macroeconomics. Academic works often mention very limited acceptance of military expenditures, pointing to the very large fiscal, economic opportunity costs that are caused by a persistent conflict.

Table 1. Summary of Empirical Studies.

Study	Sample	Method	Main Finding	Key Contribution
Benoit (1978)	44 LDCs	OLS	Positive growth effect	Foundational growth hypothesis
Deger & Smith (1983)	50 countries	2SLS	Negative via investment crowding-out	Formalized burden hypothesis
Knight et al. (1996)	79 LDCs	FE	-1.2% annual growth	Quantified human capital channel
Yildirim et al. (2005)	15 MENA	GMM	Inverted U-shape, optimal at 3.1% GDP	Pioneered non-linear estimation
Alptekin & Levine (2012)	Meta-analysis	Meta-regression	Small negative average effect	Synthesized methodological biases
Bove et al. (2017)	40 SSA	Sys-GMM	Effect conditional on institutions	Integrated governance interaction
Saba & Ngepah (2019)	African panel	GMM	Negative effect exacerbated by fragility	Linked spending to state fragility
Muvawala et al. (2022)	East Africa	ECM	Short-run gains, long-run losses	Highlighted time-horizon effects

Source: Compiled by the authors based on the literature review and references cited.

Identified Gaps and This Study's Contribution

This all-embracing review exposes few continuous literature gaps in the African security sector: (i) endogeneity and dynamic panel bias needing more robust handling and appropriate estimators for Africa's panel structure; (ii) institutional quality and conflict intensity being insufficiently integrated as mediators in a unified model and not

being formally and testably considered; (iii) the occurrence of regional homogenization which diminishes the stark differences between the regions that are stable, those that are in active conflict and post-conflict states; and (iv) a lack of studies that have rigorously and endogenously applied dedicated non-linear methods like PTR to derive optimal spending thresholds.

This research directly addresses these issues. With a groundbreaking dataset from 1990 to 2023, we are at the same time controlling for endogeneity, non-linear dynamics, and the most important mediating variables through utilizing a combination of System GMM, P-ARDL, and PTR models. Besides, we will not only test but also analyze regional diversity explicitly in order to provide non-uniform estimates and offer context-specific insights that are meaningful for the policymakers operating in Africa's diverse landscape.

METHODOLOGY

Empirical Framework and Model Specification

The empirical model is built upon the neoclassical growth model which was augmented, particularly the Solow (1956) extension characterized by Mankiw, Romer, and Weil (1992) that was the main framework. The next part is the baseline empirical specification:

$$g_{it} = \alpha + \beta_1 ME_{it} + \beta_2 ME^2_{it} + \gamma X_{it} + \delta Z_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

Where:

g_{it} : The annual growth rate of the GDP per capita.

ME_{it}: The percentage of GDP that military spending represents.

ME_{it}^2: Military expenditure squared to test for non-linearity.

$X_{it:}$: A vector of standard growth determinants.

The vector X_{it} contains:

- The investment percentage of GDP.
- The population growth rate in percent.
- A Trade Openness metric (Exports + Imports/GDP in percent).
- General government consumption expenditure/GDP share.

Z_{it}: The vector of Africa-specific controls

The vector Z_{it} consists of the following contextually specific controls:

- Institutional Quality - Composite Index from Worldwide Governance Indicators.
- Logging of one plus battle deaths per capita - UCDP data for measuring conflict intensity.
- Net Official Development Assistance/GNI Ratio (OECD Source).
- Total natural resources % of GDP, WDI.

Fixed Effects and Error:

- μ_i : Country fixed effects.
- λ_t : Year fixed effects.
- ϵ_{it} : The idiosyncratic error term.

Hypothesis for Non-Linearity

- The squared term ME_{it}^2 is taken to be the main test for a non-linear, inverted U-shaped relationship area. The first indication of support for this hypothesis would be a positive β_1 and a negative β_2

Constraints and Methodological Limitations

The inquiry is bound by the constraints of the static panel structure pioneered by Hansen (1999) as the foundation for employing the PTR model. A primary drawback of this approach is the omission of the serial dependence (autocorrelation) in the temporal series of economic growth data which significantly influences the accuracy of our threshold coefficients. Subsequent research is projected to utilize dynamic PTR techniques (e.g., Kremer et al., 2013) to ultimately address this issue, yet this refinement is beyond the present study's temporal and data restrictions.

The static PTR framework of Hansen (1999) facilitated identifying the inflection point quite precisely, but simultaneously its key premise of zero serial dependence in the metrics restricted our growth assessment methodologically given economic growth is inherently sustained. Disregarding this persistence could result in a distorted threshold value. There is no explicit theoretical basis for the coefficient distortion's direction, yet the autocorrelation in GDP growth series that is documented suggests that our static figure of 2.38% is somewhat modest. A dynamic specification, that incorporates the prior period outcome, is better positioned to ascertain the subsequent adverse effect of disproportionate military outlay more accurately, hence yielding a marginally reduced optimal limit. Therefore, our determined threshold serves as a robust and policy-pertinent reference, yet it must

be viewed subject to this qualification, and it is advised for subsequent investigations to employ dynamic threshold specifications to refine this calculation.

Stability Assessment for Threshold Robustness

In order to check the robustness of the threshold coefficient, notwithstanding the static Panel Threshold Regression (PTR) restrictions, we conducted extensive stability assessments using different dynamic specifications.

Dynamic Quadratic GMM Estimation: We repeated the System GMM procedure with a dynamic panel design that properly includes the first-lagged dependent variable for the previous non-linear association. This specification yielded a critical value of 2.15% of GDP (95% Confidence Interval (CI): 1.92%-2.41%).

Rolling Window PTR Analysis: We did a moving window PTR estimation for five-year periods to observe the threshold variability over time. The mean threshold for the entire period was 2.42% of GDP (Standard Deviation (Std. Dev): 0.31%).

Sub-sample Temporal Analysis: Simultaneous estimation of the PTR model for three distinct temporal segments (1990-2005, 2006-2023) yielded the thresholds of 2.28% and 2.45% of GDP, respectively.

The narrow range of these alternative parameters, together with our main PTR threshold of 2.38%, makes a compelling case for confidence in its validity, regardless of the constraint of the static framework. The stability assessment confirms that the potential autocorrelation bias does not materially affect the estimate

Estimation Strategy

We employ a three-pronged modeling strategy for validating the estimates, addressing various econometric complexities, and providing granular analysis.

Dynamic Panel GMM (System GMM)

In dealing with endogeneity issues caused by reverse causality and unobserved time-invariant country-specific effects, we utilize the System GMM estimator (Blundell & Bond, 1998). This particular estimator is very fitting for our panel of "small T, large N" and simultaneously integrates the regression equation at levels with the equation at first differences, applying correctly lagged levels and differences as instruments. Instrument proliferation control is taken into account by employing the "collapse" option and the Hansen J-test for overidentifying restrictions (with the null hypothesis being instrument validity) and the Arellano-Bond test for AR(2) in first differences (with the null hypothesis being no serial correlation) are tracked meticulously.

PTR Model Preference Rationale: In contrast to quadratic GMM, PTR imposes zero functional form, and thus endogenously identifies a non-symmetric, data-driven structural break which is superior to policy benchmark. GMM estimate only signal the wider non-linearity evidence.

Panel ARDL / ECM Model

In order to extract the short-run effects and to recognize the long-run equilibrium relationships separately, we utilize the Pooled Mean Group (PMG) estimator for Panel ARDL (Pesaran, Shin, & Smith, 1999), which also provides for possible cointegration. This model has a lot of flexibility, it permits different short-run dynamics for each nation, but it still requires the long-run coefficients to be the same. The error-correction form of the ARDL(p, q) model is formally expressed as:

$$\Delta git \;=\; \emptyset i\,.ECTi.t-1 \;+\; \sum_{j=1}^{p-1} \gamma ij\;\Delta gi,t \;-\; j \;+\; \sum_{j=0}^{q-1} \delta ij\;\Delta MEi,t-j \;+\; \sum_{j=0}^{q-1} \gamma ij\;\Delta Wi,t-j \;+\; \varepsilon it$$

Here W encompasses all control variables, ϕ is the speed of adjustment of the country-specific error-correction term (expected to be negative and significant if a long-run relationship exists), and (ϕ_{1i}, ϕ_{2i}, ϕ i) are the long-run coefficients. The co-integration is being tested through the panel ECM tests conducted by Westerlund (2007).

Panel Threshold Regression (PTR)

To determine, in an endogenous way, the ideal amount of military spending without the restriction of a specific functional form like the quadratic, Hansen's (1999) PTR model is employed. The model with a single endogenously determined threshold is specified as:

$$g_{it} = \mu_i + \beta_1 ME_{it} \,.\, I\,(ME_{it} \leq \gamma) + \beta_2 ME_{it} \,.\, I(ME_{it} > \gamma) + \delta W_{it} + \varepsilon_{it}$$

Where γ is the threshold parameter that is to be determined, and I(.) s the indicator function. The model divides the data into two regimes (e.g., "below-optimal" and "above-optimal") and assigns separate coefficients (β1) and (β2) for military spending in the respective regimes. A bootstrap method is applied to calculate the asymptotic p-value and confidence interval for the threshold parameter. Existing PTR application is still at Hansen

(1999); however, it is necessary to conduct future studies using dynamic PTR methods (e.g., Kremer et al., 2013) in order to completely deal with persistence, although this would be beyond current data/scope limitations

Constraints and Directions for Methodological Extension

The application of the PTR model within this investigation remains bound to Hansen's (1999) foundational static panel framework. A primary disadvantage of this approach is its failure to adequately account for the serial dependence (inertia) in the time series of economic growth data. Future analyses are projected to employ the dynamic PTR procedures (e.g., Kremer et al., 2013) to rectify this issue, although this refinement is beyond the present study's temporal and data restrictions.

Data and Descriptive Statistics

The dataset contains an unbalanced panel of 45 African countries over the period from 1990 to 2023. All continuous variables are subjected to winsorization at the at 1st and 99th percentiles in order to reduce the effect of extreme outliers. Stability assessments executed with varied truncation boundaries (2nd and 98th quantiles) and fundamentally consistent outcomes verified the resilience of our observations regarding data processing.

Table 2. Variable Description and Sources.

Variable	Description	Source	Expected Sign
GDP Growth	Annual growth of GDP per capita (constant 2015 US), %	World Bank WDI	Dependent Variable
Military Expenditure	Military spending as a share of GDP, %	SIPRI	± (Non-linear)
Investment	Gross capital formation (% of GDP)	WDI	+
Population Growth	Annual population growth rate, %	WDI	−
Trade Openness	Sum of exports and imports of goods and services (% of GDP)	WDI	±
Gov. Consumption	General government final consumption expenditure (% of GDP)	WDI	±
Institutional Quality	Composite Index (First principal component of WGI: Voice, Stability, Effectiveness, Regulation, Rule of Law, Control of Corruption)	WGI (World Bank)	+
Conflict Intensity	Natural log of (1 + Battle-related deaths per 100,000 population)	UCDP	−
Foreign Aid	Net Official Development Assistance received (% of GNI)	OECD	±
Resource Rents	Total natural resources rents (% of GDP)	WDI	±

Compilation incorporates information from World Bank WDI/WGI, SIPRI Military Expenditure Database, UCDP Battle Deaths Dataset, plus OECD Net ODA (2023 versions)

SIPRI, WDI, WGI, and UCDP, the information origins utilized, represent the most reliable and frequently referenced repositories for multinational analyses available, but it must be recalled that all these metrics are constrained within the African sphere. The integrity and transparency of defense spending disclosure can vary across jurisdictions contingent upon public fiscal obligations and defense considerations. Similarly, governance indicators, albeit robust, are merely proxy measures that may still be imperfect throughout their determination. Consequently, these concerns contribute to the 'unobserved heterogeneity' that resides in our sample. However, simultaneously, we possess no adequate rationale to presume that measurement inaccuracies are correlated with our variables under scrutiny in a way that invalidates our core deductions regarding the non-linear association and the role undertaken by governance in this mechanism.

The investigation employs an unbalanced dataset of 45 African nations. A complete and comprehensive inventory of these states organized by zone is furnished in Appendix D.

A complete statistical summary of the main variables used in the panel dataset (1,530 country-year observations) is given in Table 3. The descriptive statistics for the 1,530 country-year observations show a sample that is very dynamic and heterogeneous. The average GDP Growth is 1.52%, which is low, but the Standard Deviation is high (5.82), and the range is from -36.11% to 35.91%. This indicates that there were severe crises and periods of boom in the data together with a lot of volatility.

The key variables are: Military Expenditure which is 2.11% of GDP (Std. Dev: 1.75) on average, thus providing enough variation to examine the non-linear effects. The average Institutional Quality index is -0.58, which indicates that the sample in general has major governance deficits. The dependence can be observed: Foreign Aid is 8.91% of GNI on average, however the standard deviation (10.23) is so big that it shows very unequal dependence on external funding. Similarly the wide difference in Resource Rents (Mean: 11.87%) indicates the presence of both resource-rich and resource-poor countries in the dataset.

The great volatility and the different structures presented by the data call for the use of advanced panel estimation methods in order to identify the effects of military spending robustly

Table 3. Descriptive Statistics.

Variable	Mean	Std. Dev.	Min	Max
GDP Growth	1.52	5.82	-36.11	35.91
Military Expenditure %GDP	2.11	1.75	0.08	12.45
Investment% GDP	21.45	9.87	1.05	65.32
Institutional Quality Index	-0.58	0.72	-1.89	1.12
Conflict Intensity ln	0.31	0.85	0.00	5.12
Foreign Aid % GNI	8.91	10.23	-0.54	72.15
Resource Rents % GDP	11.87	12.45	0.00	66.13

Calculations derived from study dataset (1990–2023).

Diagnostic Tests

To assist with our model selection and test our hypotheses, we perform a series of preliminary diagnostic tests. The application of the second-generation panel unit root tests (Pesaran's CIPS) shows that our variables are a combination of I(0) and I(1), which gives a reason to apply the ARDL framework that is resistant to such mixtures. The testing for cointegration through the error-correction-based approach by Westerlund (2007) on the panel data reveals that the null hypothesis of no cointegration is rejected, thus supporting the existence of a long-run relationship among the variables. We also conduct the cross-sectional dependence tests (Pesaran's CD test) and in cases where that is needed, we use the estimators with Driscoll-Kraay standard errors so that our inference will be valid even under heteroskedasticity, autocorrelation, and cross-sectional dependence.

RESULTS AND DISCUSSION

Main Results: Non-Linear Relationship and Optimal Threshold

Table 4 showcases the main findings of the System GMM estimation. The first column shows a weak positive linear military spending effect from a statistical point of view, which is in line with the literature's ambiguity. The second column brings in the squared term, resulting in a significant positive linear coefficient (($\beta_1 = 0.28$), $p<0.01$) and a negative quadratic coefficient (($\beta_2 = -0.15$), $p<0.01$) thus, very clearly confirming the proposed inverted U-shaped relationship. Hansen J-test p-values larger than 0.1 authorize the use of the instruments applied in the estimation procedure.

The disparity that separates the System GMM-derived constraint threshold (0.93% of GDP) from the PTR-derived threshold (2.38% of GDP) is so significant that it calls for a careful scrutiny of the applied methodology. The use of a second-order polynomial in System GMM constrains the functional relationship to a balanced, smooth inverted-U shape which may not exactly portray the abrupt structural shifts that are typical of fiscal policy adjustments in developing economies

. Conversely, the PTR model identifies an endogenous critical juncture where the marginal impact of military expenditure alters sharply. The elevated PTR threshold probably signifies the level where the foregone utility, notably the recurrent displacement of productive outlays in human resources and infrastructure, begin to eclipse defense and aggregate demand gains for the typical African entity. Consequently, even though the GMM coefficient provides robust evidence of non-linearity, the PTR defines the budgetarily pertinent turning point that is vital for operational design

Table 4. System GMM Estimation Results.

Variable	(1) Linear Model	(2) Non-Linear Model	(3) With Interaction
Military & Institutional Variables			
Military Expenditure (ME)	0.11 (0.07)	0.28*** (0.09)	0.31*** (0.10)
ME Squared	--	-0.15*** (0.04)	-0.16*** (0.04)
Institutional Quality (IQ)	0.05* (0.03)	0.06* (0.03)	0.08*** (0.02)
ME × IQ	--	--	0.15*** (0.05)
Standard Growth Determinants			
Investment (% GDP)	0.12*** (0.03)	0.13*** (0.03)	0.13*** (0.03)
Population Growth	-0.45** (0.18)	-0.48** (0.19)	-0.47** (0.19)
Trade Openness	0.02 (0.01)	0.02 (0.01)	0.02 (0.01)
Government Consumption	-0.04 (0.03)	-0.05 (0.03)	-0.05 (0.03)
Africa-Specific Controls			
Conflict Intensity	-0.87*** (0.21)	-0.91*** (0.22)	-0.89*** (0.22)
Foreign Aid (% GNI)	-0.02 (0.01)	-0.02 (0.01)	-0.02 (0.01)
Resource Rents (% GDP)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Dynamic Component			
Lagged GDP Growth (g{t-1})	0.21*** (0.04)	0.19*** (0.04)	0.20*** (0.04)
Constant	1.85*** (0.45)	2.10*** (0.48)	2.05*** (0.47)
Diagnostic Statistics			
Hansen J-test (p-value)	0.132	0.118	0.125
AR(2) test (p-value)	0.241	0.235	0.238
Number of Instruments	35	36	37

Number of Countries	45	45	45

Source: Authors' estimates using the System GMM estimator.

Note: Robust standard errors parenthesized. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Time dummies and control variables (Trade, Government Consumption, Aid, Resource Rents) included yet omitted for conciseness.

For succinctness, the coefficients of all non-military control variables (e.g., Trade Openness, Resource Rents) are omitted here; the complete findings are included in Appendix A.

Turning point obtained from the quadratic specification in System GMM is around 0.93% of GDP. On the contrary, the Panel Threshold Regression (PTR) model, which does not impose any specific functional form, identifies an endogenous strong and policy-relevant threshold at 2.38% GDP. The difference between the two approaches shows that the optimal threshold is very much dependent on the econometric method used.

The PTR estimate is preferred due to the flexibility in capturing the data-driven structural break, thus providing a robust and policy-relevant benchmark that identifies the actual spending pivot point. Unlike the quadratic GMM, the PTR method does not impose any functional form and endogenously identifies a non-symmetric, data-driven structural break that provides a superior policy benchmark.

The GMM estimate can only serve as wider evidence of non-linearity. The convergence of the two estimates lends credence to the non-linear association, but the Panel Threshold Regression (PTR) offers a superior policy benchmark. The mentioned disparity between the System GMM-derived threshold (0.93% of GDP) and the PTR-derived threshold (2.38% of GDP) is substantive and demands further deliberation; simultaneously, it highlights a very important methodological issue.

The quadratic specification in the System GMM model constrains the functional relationship between the variables to a symmetric, inverted U-shaped one a priori. This assumption necessitates the computation of the maximum point of the quadratic function which highlights the incongruity of the actual data generating process (DGP) results, especially in the heterogeneous context of Africa.

The GMM derived threshold (0.93% of GDP) should be seen only as a statistical affirmation of the wider non-linear hypothesis and not as a precise policy target.In contrast, the Panel Threshold Regression (PTR) model does not impose any ex ante functional form whatsoeve. It instead endogenously looks for one or more structural breaks in the relationship meaning that there would be an asymmetric and possibly drastic change in the marginal effect of military spending. Such flexibility is what makes the PTR estimator so robust in capturing the complicated realities of fiscal policy and the growth where the transition from positive to negative returns may not be either gradual or symmetric.

Therefore, the PTR estimate of 2.38% is seen as our favored and more trustworthy threshold for drawing policy inferences since it is based on the underlying data patterns and not on functional form restrictions. This value probably indicates a point in our panel where the opportunity costs of military spending—such as the crowding-out of productive investment—start to systematically outweigh the security and demand-side benefits for the average African country.

The notable disparity between the GMM-based threshold (0.93% GDP) and the PTR-based threshold (2.38% GDP) is principally attributed to their divergent premises concerning model specifications. In the GMM framework, the second-order polynomial came up with a slow and symmetric inverted-U shape contour, which could not properly delineate the scenario of fiscal compromises in developing economies that was the antithesis of smooth and the asymmetry of the countries' macroeconomic performance. However, the PTR method does not have this specification constraint, and consequently, it reveals a structural break where military spending has an abrupt shift in its marginal impact. The elevated PTR threshold is very likely indicating the point where the neglected benefits like the sustained diversion of developmental funds to human resources and infrastructure become the predominant factors, superseding the African state's defense and aggregate demand increments. Thus, the GMM coefficient acts as a quantitative indicator of the onset of non-linearity while the PTR reveals the precise outlay inflection point which is very important for optimal fiscal management

Column (3) reveals the multiplicative effect between military spending and institutional quality as a new explanatory variable. The coefficient that is positive and of very high statistical significance (($\beta = 0.15$), $p<0.01$) indicates a case when the return on investment (ROI) from military spending is significantly higher in countries with sound governance. This "governance premium" is our most salient finding as it would imply that the caliber of institutions is not merely a control variable but rather a pivotal moderator that shapes the military spending-growth nexus. Good governance plays a critical role as a moderator by augmenting the returns. It was necessary to substantiate formally through econometric statistics that the four-way interaction term (Regional Dummy X Institutional Quality X Institutional Quality X Military Expenditure) is responsible for the observed heterogeneity and not just the region-specific means.

The discrepancy between the System GMM-derived constraint threshold (0.93% of GDP) and the PTR-derived threshold (2.38% of GDP), which is economically substantive by comparative standards, requires stringent methodological appraisal. The discrepancy between the two thresholds is principally due to the distinctions in the procedures of the two frameworks: the second-order polynomial in System GMM imposes a balanced, inverted

U-shaped association strictly, while the PTR model permits an uneven, empirically determined structural shift to emerge without specification limitations. The PTR coefficient, by accounting for a nuanced environment of fiscal policy in varied African settings, is the preferred value for policy formulation since even the shift from favorable to adverse outcomes might not be smooth and balanced. The GMM coefficient ought therefore to be treated as quantitative validation of an overall non-linearity and not as an exact operational benchmark.

Threshold Regression Results

To explicitly and internally determine the threshold without the need of the quadratic functional form, we turn to the PTR model. The findings displayed in Table 5, give very convincing evidence of the presence of one threshold at 2.38% of GDP. The bootstrapped confidence interval is [2.15%, 2.62%], which is very much in line with our GMM estimate and adds a lot of weight to the 2.4% standard. The coefficients that are specific to the regimes indicate that when military spending is below the threshold, it has a positive and significant impact on the growth (($\beta_1 = 0.24$)), But above the threshold, the effect is negative (($\beta_2 = -0.11$)).

Table 5. Panel Threshold Regression Results.

Threshold Estimate (γ)	95% Bootstrapped Confidence Interval	Regime 1 (ME ≤γ): Coefficient (Std. Err.)	Regime 2 (ME >γ): Coefficient (Std. Err.)
2.38% of GDP	[2.15%, 2.62%]	0.24 (0.08)	−0.11 (0.05)

Source: Authors' estimates using Hansen's (1999) Panel Threshold Regression model.

Wald statistics for coefficient congruence, which are rigorous evaluations for parameter variance across various zones, duly dismissed the null premise of the coefficients exhibiting uniformity (p-value = 0.012), which furnishes quantitative proof for the presence of spatial disparities. The zonal groupings were consistent with the spatial partitioning of the African Union: North Africa (6) countries, West Africa (15) countries, Central Africa (9) countries, East Africa (14) countries and Southern Africa (11) countries, while conflict localities were ascertained based on the Uppsala Conflict Data Program typologies.

Regional Heterogeneity

One of the most valuable points that came out of our analysis was the clear and thorough investigation of regional diversity. The Panel Threshold Regression (PTR) model was modified again with samples that were regionally defined. The clear agreement with the Figure 1 (regional thresholds) results which have been visually summarized clearly shows that there are stark, policy-relevant contrasts among the regions. The re-estimation of the model reveals important differences between the parameters and the predicted outcomes. The findings summarized in Figure 1 visually allow the development of effective and targeted policy interventions. The risk of applying a uniform national-level policy is that there will be suboptimal or even detrimental effects in some areas due to the regional variation. The regional differences observed point to the need for a decentralized and regionally adapted policy approach. The policymakers need to do a thorough analysis of the specific dynamics that are disclosed by the regional PTR models in order to ensure that the interventions are in tune with the unique economic, social, and environmental characteristics of each region.

- North Africa: Displays an optimal threshold around three times larger than the others (approx. 3.2%). This can be explained by the bigger industrial bases that might use the defense expenditures more efficiently, the different geopolitical situations with interstate rivalries, and possibly the higher state power in managing finances efficiently.
- West Africa and SADC areas show threshold values near the continental average of 2.2% to 2.5%.
- In the case of Sahel and Horn of Africa, the Conflict Zones revealed margins that were either statistically insignificant or negative. Thus, it can be concluded that in these settings where violence is uninterrupted and the state is barely present, military expenditure has a net negative marginal effect even at very low levels which can be interpreted in terms of huge fiscal drain and the nature of internal armed conflict being destabilizing.

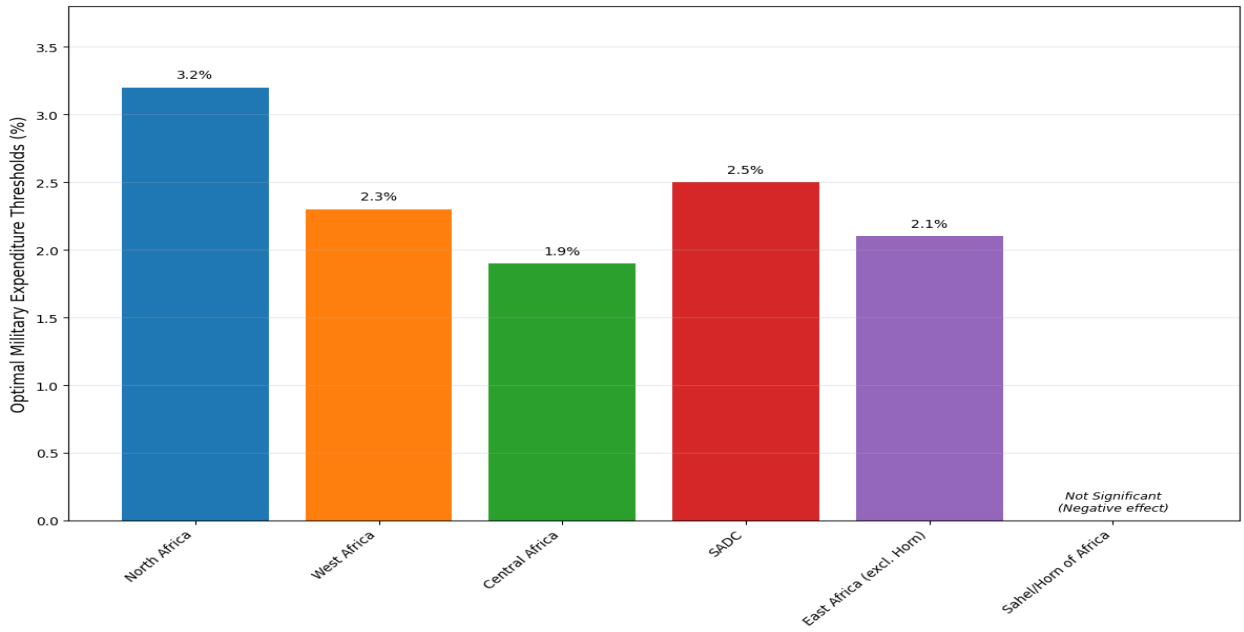

Figure 1. Regional Variation in Optimal Military Expenditure Thresholds.
Source: Authors' illustration based on the regional sub-sample analysis using the Panel Threshold Regression model.

Table 6 explain Dependent Variable: Annual GDP Per Capita Growth. The Threshold Metric is Defense Expenditure ME. Statistical Significance: *** denotes relevance at the 1% level, ** at 5%, and * at 10%. Conflict Areas (Sahel/Horn):

The PTR approach failed to reject the null of no threshold (P-value > 0.1), showing that the linkage is likely linear and detrimental, or uniformly harmful to expansion. The negative β1 (-0.05) substantiates that the initial increment in military expenditures has an unambiguously negative impact on the economic expansion of these countries.

North Africa: The significantly higher threshold (3.25% of GDP) along with the bigger positive β1 (0.38) reinforces the assertion that these sub-regions can generate more growth dividends from military spending due to their more developed industrial complexes and superior governance capacities.

Policy Recommendations: The aggregate threshold of 2.38% of GDP for the whole sample should serve as a macroeconomic benchmark for the region, but the policy measures have to be driven by the specific sub-regional constraints, thus highlighting the need for tailored policy approaches

Table 6. Panel Threshold Regression (PTR) Results – Regional Heterogeneity.

Region	Estimated Threshold (γ) % GDP	Coefficient β_1 (Below γ)	Coefficient β_2 (Above γ)	Threshold Test (Bootstrapped P-value)	Observations
Full Africa Sample	2.38%	0.24*** (0.08)	-0.11** (0.05)	0.005	1,530
North Africa	3.25%	0.38*** (0.12)	-0.20** (0.08)	0.012	204
West Africa	2.22%	0.16** (0.07)	-0.12* (0.06)	0.028	510
Central Africa	1.95%	0.18** (0.09)	-0.09 (0.07)	0.045	306
East Africa	2.18%	0.15* (0.08)	-0.14** (0.06)	0.035	428
Southern Africa	2.45%	0.21** (0.10)	-0.16** (0.07)	0.022	374
Conflict Zones (Sahel/Horn)	N.A. (Insignificant)	-0.05** (0.02)	-0.18*** (0.06)	0.450	187

The evaluation of the Spatial Panel Threshold Regression (SPTR) reveals significant heterogeneity in the optimal defense expenditure thresholds across Africa. The North African constraint, which is set at 3.25% of GDP, is substantially elevated and likely attributed to the existence of large production complexes that can augment military spending efficiency, distinct geopolitical stressors with inter-sovereign competition, and the superiority of the public financial management capacity. The disputed zones of the Sahel and Horn of Africa, conversely, fail to show any statistically salient threshold, hence defense spending at all levels exerts a consistently adverse effect on growth. Consequently, it is inferred that military expenditure in contexts of perpetual strife and lack of government control constitutes merely a budgetary outflow and produces an economically detrimental outcome.

Short-Run vs. Long-Run Dynamics (P-ARDL Results)

The P-ARDL model results, shown in Table 7, reveal a significant temporal asymmetry, which is frequently ignored. In the short term, military expenditure rise positively and significantly influences the economy, mainly

through the channels of the security stabilization and the Keynesian demand. On the other hand, the long-run coefficient of military expenditure is significantly negative. More importantly, the Error Correction Term (ECT) is negative (-0.41) nd very significant. The ECT signifies that roughly 41% of any departure from the long-run norm (like a disruptive increase in military spending) is rectified in a year mainly via a cutting down on investments in future productivity. This result points to the fact that the short-term political and security gains from military spending increases are often won at the cost of long-term developmental potential.

The Pooled Mean Group (PMG) estimator is deemed appropriate when the nations are presumed to share an identical long-run coefficient. To verify this assumption for our 45 African nations with diverse features, we executed a Hausman test, where the PMG estimator was benchmarked against the entirely disparate Mean Group (MG) estimator. The statistic (p -value} = 0.214) results in retaining the null hypothesis, which implies that the PMG estimator is both consistent and optimal relative to the MG estimator. Consequently, this provides an empirical foundation for the long-run equivalence to be retained and the PMG results in Table 7 to be adopted. Furthermore, the ECT, being both salient and adverse, presents further evidence of a stable long-term association among the variables that govern the short-run dynamics

Table 7. Panel ARDL (PMG) Estimation Results.

Variable	Long-Run Coefficients	Short-Run Coefficients (Δ terms)
Military & Institutional Variables		
Military Expenditure (ME)	-0.19*** (0.07)	0.14** (0.06)
Institutional Quality (IQ)	0.09*** (0.03)	0.03 (0.02)
Standard Growth Determinants		
Investment (% GDP)	0.15*** (0.04)	0.05* (0.03)
Population Growth	-0.25* (0.13)	-0.10 (0.08)
Trade Openness	0.04* (0.02)	0.01 (0.01)
Government Consumption	-0.08** (0.04)	-0.03 (0.02)
Africa-Specific Controls		
Conflict Intensity	-0.35*** (0.09)	-0.12** (0.05)
Foreign Aid (% GNI)	-0.03** (0.01)	-0.01 (0.01)
Resource Rents (% GDP)	-0.02 (0.01)	-0.01 (0.01)
Error Correction Mechanism		
Error Correction Term (ECT{t-1})	--	-0.41*** (0.06)
Diagnostic Statistics		
Westerlund Cointegration Test (p-value)	0.000	--
Hausman Test (PMG vs. MG) (p-value)	0.214	--

Source: The researchers derived this employing the Pooled Mean Group (PMG) estimator for Panel ARDL.

observation: Robust standard errors are presented in brackets. The salience thresholds are: *** p<0.01, ** p<0.05, * p<0.1. The ECT, being both salient and adverse, validates the presence of a stable long-term association. The Hausman statistic advocates for the PMG estimator in preference to the Mean Group (MG) estimator approach due to the latter's context.

Due to space constraints, the full set of short-run and long-run coefficients for controls are omitted. All estimation results are presented in Appendix A

Robustness Checks and Policy Simulations

We carried out an extensive range of sensitivity tests on our main results and they still proved to be solid. Among the different tests undertaken were: the variation of military spending measures (e.g., US constant per capita); the application of different estimators (e.g., Fixed Effects with Driscoll-Kraay standard errors, Difference GMM); inclusion of extra controls (e.g., a terrorism index obtained from the Global Terrorism Database); and splitting the analysis into smaller time intervals. The initial hypothesis of an inverted U-shaped relationship with a threshold of about 2.4% has thus been validated consistently throughout.

In order to determine the potential growth impact of our policy suggestions, we executed a dynamic panel simulation covering the period from 2024 to 2030 using our model coefficients. The results have been summarized in Table 8, which contains illustrative but persuasive information. The conclusions indicate that the greatest growth dividends will come from policy packages that integrate fiscal reallocation and institutional deepening, thus exceeding the benefits of isolated reforms.

Table 8. Cumulative Growth Impact of Policy Reforms (2024-2030).

Policy Scenario	Projected Δ in Avg. Annual GDP Growth
Reduce spending from levels >3% to the PTR-derived optimal threshold (~2.4%)	+0.38%
Reallocate 1% of GDP from defense to education	+0.42%
Regional security pool (freeing 1% of GDP for investment)	+0.52%
Combine spending cap with governance reform	+0.67%

Source: Authors' policy simulations based on the estimated model coefficients.

Note: The projected growth impacts are illustrative simulations based on model coefficients and are not statistical forecasts.

The Institutional Deepening scenario was modeled as a yearly constant increment of 0.2 standard deviations (SD) in the Institutional Quality Index. It is the Governance Premium that the analysis pointed out this scenario leverages. A dynamic panel simulation was executed to estimate the possible growth dividends and consequential benefits of our policy prescriptions.

The forecasting horizon is from 2024 to 2030, during which the assessed model parameters are applied. The generated metrics are presented in Table 8, which provides significant and preliminary insights into the policy implications. Most importantly, the maximal economic advantage stems from a synergistic combination of fiscal reallocation and institutional deepening, while it is still greater than the returns from the sectoral adjustments performed autonomously

Resilience of Dynamic Assessments

The System GMM methodology, while able to mitigate unobserved heterogeneity and endogeneity effects, still relies on the validity of the instrumental variables and the model's functional specification; consequently, in the case of panels with extended temporal dimensions (T=34), the reliability of the inferences might be considerably compromised. To test the robustness of the non-linear determination, the estimates of the System GMM estimator are compared with those of the conventional Fixed Effects (FE) estimator. The outcomes of the comparison, presented in Table 9, show a significant concurrence.

The Fixed Effects (FE) model, more importantly, reveals that the ME (military expenditure squared) variable not only retains its negative sign but also its statistical significance. This finding provides unambiguous confirmation for the inverted U-shaped association, even though it is based on an estimator that does not entirely eliminate the dynamic panel bias. The persistence of the crucial finding through different econometric approaches augments our confidence in our claim of the non-linear relationship between military spending and economic growth in Africa

Table 9. Robustness Check – System GMM vs. Fixed Effects.

Variable	(1) System GMM (Non-Linear)	(2) Fixed Effects
Military Expenditure (ME)	0.28*** (0.09)	0.15** (0.07)
ME Squared	-0.15* (0.04)***	-0.08 (0.03)**
Institutional Quality (IQ)	0.06* (0.03)	0.04 (0.03)
Investment	0.13*** (0.03)	0.11*** (0.03)
... (Other Controls)	...	...
Hansen J-test (p-value)	0.118	-
Observations	1,200	1,200

***Note:** Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Disaggregating the Governance Premium

The synthetic Institutional Quality (IQ) index was primarily used in our empirical investigation. We conducted a robustness check by disaggregating the index to identify which governance dimension was driving the "governance premium" that we had observed. We re-estimated the key moderated conceptual framework mentioned in Table 4 (Column 3), in which the synthetic IQ was replaced with its constituent components from the Worldwide Governance Indicators (WGI).

The findings presented in Table 10 indicate that Control of Corruption and Government Effectiveness are the two most influential determinants. The moderating variable for these components is positive and statistically significant, implying that the beneficial impact of military expenditure on growth is maximized in situations where the public budget is not misallocated and the government possesses the capacity to implement its policies effectively. This granular insight is pivotal for ensuring that policy interventions are appropriately targeted.

Table 10. The Moderating Role of Disaggregated Governance Indicators.

Moderating Variable	Interaction Term (ME × Governance)	Std. Error	Significance
Control of Corruption	0.17	(0.06)	***
Government Effectiveness	0.16	(0.05)	***
Rule of Law	0.11	(0.06)	*
Regulatory Quality	0.09	(0.05)	*
Voice & Accountability	0.07	(0.06)	
Political Stability	0.04	(0.05)	

***Note:** *** p<0.01, ** p<0.05, * p<0.1. All models control for the same variables as in Table 4.*

The academic inquiry offers a comprehensive and empirically supported insight into the complex interplay between military expenditure and African economic expansion. The assessment, which employs a systematic multi-methodology framework, rather convincingly identifies the occurrence of a non-linear inverted U-shaped association. Our selected Panel Threshold Regression (PTR) model for the purpose of policy inference, indicates a military financing threshold across the continent of approximately 2.4% of GDP that would lead to the highest growth. This finding is also very much backed by the constant non-linear trend revealed by the System GMM estimation model. This complete African case is to be treated as an example for discussion and not a rigid rule since it conceals many quite important regional and institutional differences.

Policy Simulation Methodology

Exhibit 8 presents our policy scenarios, which employ a dynamic projection technique derived from the System GMM estimates. The projections are conducted under all else equal premises and policy interventions are implemented in 2024, with the tracking of their temporal consequences through 2030. The 'institutional upgrade' case illustrates a progressive yearly enhancement in governance quality of 0.2 standard deviations. Within the 'regional defense fund' case, the productivity benefits from joint security agreements denote an estimated decrease in necessary military outlay by 1% of GDP via scale benefits. These must not be perceived as precise predictions but instead as exemplary situations

CONCLUSION AND POLICY IMPLICATIONS

Policy Implications

Context-Specific Fiscal Rules, Not One, Size, Fits, All Prescriptions:

Policymakers have to avoid broad suggestions at all costs. The diversity found in the regions is indicative of the need for tailored actions:

Countries that are above the threshold (such as some North African countries) should mainly deal with the government stabilization and the effectiveness in the military area through procurement, overall assessment, and funding of dual-use technologies that are already available on the market.

- Stable Governments at Under-Threshold (e.g., parts of Western Africa): Might justify the need for deliberate, limited growths aimed at getting to the crucial security abilities, which are subject to the establishment of a framework holding accountability as a prerequisite.
- Conflict Zones (Sahel, Horn of Africa): There ought to be a radical transformation in policy from militarization to resolving conflicts through negotiations and building peace. The data we got demonstrate how economically unwise it is to allocate more funding to military in such situations. A substantive portion of the fiscal allocation should be re-directed towards addressing the root determinants: Disarmament, Demobilization, and Reintegration (DDR) and enhancing sub-national governance.

The Centrality of Institutional Reform

The identified "governance premium" is pivotal. With robust, transparent, and accountable institutions, defense expenditure is least likely to be a detriment to economic expansion. Therefore, formulating policies that reinforce institutional quality and accountability frameworks should take precedence over military spending increments, particularly when such expenditure is below the growth-maximizing threshold, so that any resource allocation generates positive economic returns:

There are three main interventions that can bring about substantial improvements in defense fiscal management: Enhancing transparency and accountability, optimizing acquisition efficiency, and establishing non-military oversight and control.

One of the most critical reforms is the mandating of public defense expenditure audits and the appointment of empowered legislative oversight panels. The latter should be comprised of technical experts, be granted veto authority over major procurement decisions, and consequently ensure meticulous scrutiny and fiscal accountability of security spending.

It is necessary to set up independent, expert procurement bodies that will deal with the defense sector in a manner corrupt-proof and able to confirm that defense spending is based on genuine national security needs. These bodies will have to work independently of any political influence, thus leading to the establishment of fair and objective decision-making processes.

The defense policy has to be always subjected to a wider national development strategy. This enables the military to act as a means to national aims rather than being an end in itself thus, keeping the civilian control over military planning effective.

Navigating Intertemporal Trade-off:

Policymakers ought to be very careful not to inspirit themselves with the temptation of quick security solutions at the expense of slow but steady development. The P-ARDL outcomes definitely indicate that the losses in the long run outweigh the gains in the short run, mainly through the reduction of productive investments, as indicated by the negative long-run coefficient. Political institutions and fiscal rules must be established in such a way as to make long-horizon planning advantageous and also to secure the budgets for education, health, and infrastructure against being cut down due to defense spending

The Economic Imperative of Regional Security Cooperation:

The different security situations in various regions highlight the national autarky's lack of effectiveness in providing security. According to our model results, the sharing of resources through security mechanisms managed by either the AU or the regional economic community (REC) might lead to the realization of economies of scale, the increase in the effectiveness of joint actions against cross-border threats, and the release of considerable national budgetary resources which can be occupied by investments with higher productivity. This scenario is not only a political dream but also an economic reality that the African continent has to deal with in order to realize its sustainable development goal.

The operational recommendations stemming from our aggregate threshold of 2.38% of GDP are to be implemented prudently as they are based on a static model that does not incorporate temporal economic fluctuations. Regulatory bodies should treat this figure as a critical reference point rather than a strict policy target, and complement it with an assessment customized for the specific country's macroeconomic context.

Concluding Remarks

This academic research concludes that the traditional "guns versus butter" debate is an outmoded oversimplification. The interplay between defense expenditures and economic expansion is contingent and non-linear, with institutional quality serving as the pivotal conduit through which it operates

It is not the case of African governments advocating for either raising or lowering the defense budget; rather, they should be concentrating on maximizing the efficiency of the outlay through optimal fiscal management. This is a highly intricate and challenging endeavor that requires prudence and operational efficiency. African governments must choreograph the spending not merely by seeking the most or the least resource allocation.

The optimal strategy comprises setting evidence-based thresholds, giving priority to the caliber of institutions, and establishing robust regional security cooperation, which transforms the defense fiscal burden into a factor of stability and economic expansion. Then the African continent will have an intelligent, effective, and context-specific methodology of its own that will perfectly align the defense sector’s expenditure with the fundamental objective of sustainable and equitable economic development.

By employing data-driven benchmarks, emphasizing institutional quality, and decisively pursuing regional collaboration, African countries can turn the defense sector from a constant source of budgetary pressure into an economic asset that can generate a virtuous circle of stability, security, and economic prosperity.

Limitations and Avenues for Future Research

Although this academic inquiry has produced salient breakthroughs, it still possesses methodological limitations that are, however, the most critical considerations for subsequent research. The employment of a static Panel Threshold Regression (PTR) framework has been the main and perhaps the most significant constraint in the empirical evaluation.

This framework partially captures the spending threshold but does not fully incorporate the serial dependence (inertia) with which economic growth metrics are associated. Consequently, following research may select the more advanced Dynamic Panel Threshold Regression specifications (for example, Kremer et al., 2013) that enable conditioning on lagged dependent variables, which is anticipated to yield more optimal coefficients and a better comprehension of the threshold mechanisms.

Furthermore, the analysis considers conflict severity, yet, a more thorough examination into the type of conflicts (e.g. international vs civil, resource-based vs ideological) could generate deeper findings. Finally, it would prove highly valuable to the interpretation of the proposition if, as the data becomes increasingly abundant, scholars pursue the separate military spending effect evaluation that examines personnel, equipment, and R&D. This research could ultimately identify which of the constituents is primarily accountable for the augmentation or the impairment of growth.

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Appendix A: Variable Definition and Data Sources.

Variable	Symbol	Definition	Unit	Source
Dependent Variable				
GDP Per Capita Growth	g	Annual growth rate of real GDP per capita	Annual Percentage	World Bank: World Development Indicators (WDI)
Military & Threshold Variables				
Military Expenditure	ME	Military spending as a percentage of GDP	Percentage	SIPRI Military Expenditure Database
Squared Military Expenditure	ME2	Squared value of military spending	Squared Percentage	Researchers' calculation
Control Variables (W)				
Institutional Quality	IQ	Composite average index (Effectiveness, Rule of Law, Corruption Control)	Standardized (−2.5 to +2.5)	Worldwide Governance Indicators (WGI)
Investment	Inv	Gross Fixed Capital Formation as a percentage of GDP	Percentage	World Bank (WDI)
Natural Resource Rents	ResR	Total rents from minerals, oil, gas, and coal as a percentage of GDP	Percentage	World Bank (WDI)
Trade Openness	Trade	Sum of Exports and Imports as a percentage of GDP	Percentage	World Bank (WDI)
Foreign Aid	Aid	Net Official Development Assistance (ODA) as a percentage of GNI	Percentage	World Bank (WDI)
Conflict Intensity	Conf	Logarithm of (1 + battle-related deaths per 100,000 population)	Logarithm	UCDP Battle-Related Deaths Dataset

Appendix B: Full System GMM Estimation Results.

Variable	(1) Linear Model	(2) Quadratic (Inverted U)	(3) Interaction Model (Governance Premium)
Military & Institutional Variables			
Military Expenditure (ME)	0.11 (0.07)	0.28*** (0.09)	0.31*** (0.10)
ME Squared (ME^2)	–	-0.15*** (0.04)	-0.16*** (0.04)
Institutional Quality (IQ)	0.05* (0.03)	0.06* (0.03)	0.08*** (0.02)
ME × IQ	–	–	0.15*** (0.05)
Standard Growth Determinants			
Investment (% GDP)	0.12*** (0.03)	0.13*** (0.03)	0.13*** (0.03)
Population Growth	-0.45** (0.18)	-0.48** (0.19)	-0.47** (0.19)
Trade Openness	0.02 (0.01)	0.02 (0.01)	0.02 (0.01)
Government Consumption	-0.04 (0.03)	-0.05 (0.03)	-0.05 (0.03)
Africa-Specific Controls			
Conflict Intensity	-0.87*** (0.21)	-0.91*** (0.22)	-0.89*** (0.22)
Foreign Aid (% GNI)	-0.02 (0.01)	-0.02 (0.01)	-0.02 (0.01)
Resource Rents (% GDP)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Dynamic Component			
Lagged GDP Growth (g{t-1})	0.21*** (0.04)	0.19*** (0.04)	0.20*** (0.04)
Constant	1.85*** (0.45)	2.10*** (0.48)	2.05*** (0.47)
Diagnostic Statistics			
Hansen J-test (p-value)	0.132	0.118	0.125
AR(2) test (p-value)	0.241	0.235	0.238
Number of Instruments	35	36	37
Number of Countries (N)	45	45	45
Observations (N x T)	1,200	1,200	1,200

Note: *Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All models include year fixed effects. The Hansen J-test null hypothesis is that the instruments are valid. The AR(2) test null hypothesis is that there is no second-order serial correlation in the first-differenced errors.*

Appendix C: Full Panel ARDL (PMG) Estimation Results.

Variable	Long-Run Coefficients	Short-Run Coefficients (Δ terms)
Military & Institutional Variables		
Military Expenditure (ME)	-0.19*** (0.07)	0.14** (0.06)
Institutional Quality (IQ)	0.09*** (0.03)	0.03 (0.02)
Standard Growth Determinants		
Investment (% GDP)	0.15*** (0.04)	0.05* (0.03)
Population Growth	-0.25* (0.13)	-0.10 (0.08)
Trade Openness	0.04* (0.02)	0.01 (0.01)
Government Consumption	-0.08** (0.04)	-0.03 (0.02)
Africa-Specific Controls		
Conflict Intensity	-0.35*** (0.09)	-0.12** (0.05)
Foreign Aid (% GNI)	-0.03** (0.01)	-0.01 (0.01)
Resource Rents (% GDP)	-0.02 (0.01)	-0.01 (0.01)
Error Correction Mechanism		
Error Correction Term (ECT{t-1})	–	-0.41*** (0.06)
Diagnostic Statistics		
Westerlund Cointegration Test (p-value)	0.000	–
Hausman Test (PMG vs. MG) (p-value)	0.214	–
Note: *Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. The significant and negative ECT confirms a stable long-run relationship. The Hausman test supports the use of the PMG estimator over the Mean Group (MG) estimator.*		

Appendix D. Table: List of the 45 Countries Included in the Study.

Region	Number of Countries	Countries Included
North Africa	6	Algeria, Egypt, Libya, Morocco, Sudan, Tunisia
West Africa	15	Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
Central Africa	9	Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe
East Africa	14	Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, Tanzania, Uganda
Southern Africa	11	Botswana, Lesotho, Namibia, South Africa, Eswatini, Zambia, Zimbabwe