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Dynamic panel and nonlinear causality analytics of defense and debt in fragile Africa

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Abstract

This research integrates several analytical models to examine how rising military spending in fragile African states relates to external indebtedness between 2000 and 2023. A combination of dynamic panel methods—including System-GMM to address endogeneity, Prais-Winsten regression to correct for serial correlation, and panel Granger causality tests—is employed to develop a robust framework for exploring the fiscal-security nexus. The findings reveal a significant nonlinear dynamic: while moderate military spending appears fiscally neutral, surpassing a critical threshold transforms it into a major driver of debt accumulation. Beyond the effects of scale, increased defense spending alone does not reliably reduce conflict. Instead, strong governance, effective regulation, and sustained economic growth emerge as the most decisive factors in building lasting peace. The analysis also identifies a self-reinforcing feedback loop—a "fiscal–security trap"—in which rising debt and defense expenditures mutually reinforce one another over time. By advancing dynamic modeling of fiscal risks in fragile contexts, this research contributes to the broader objective of promoting sustainable debt management and durable peace.

Keywords: dynamic panel, Granger-causality, modeling fiscal-debt trap, sovereign debt, system-GMM.

1. Introduction

Fragile states in sub-Saharan Africa are caught in a persistent cycle of economic instability, high external indebtedness, and recurring conflict. Large military expenditures, though often justified by security needs and the fight against insurgency, tend to worsen fiscal pressures and deepen dependence on external borrowing. In these countries, the debt–military–conflict nexus is rooted in institutional and governance failures, which perpetuate a vicious cycle of underdevelopment (Saba and Ngepah, 2019). By prioritizing defense financing over essential public investments such as infrastructure, education, and healthcare, fragile states dent long-term development prospects and become increasingly reliant on debt to cover growing security costs. This cycle is neither new nor isolated; scholars like Aisen and Veiga (2013) have long established the macroeconomic consequences of defense-driven fiscal imbalances.

The military-debt nexus is particularly pronounced in fragile Sub-Saharan Africa (SSA): weak institutions, political instability, and ongoing violence shape fiscal decisions. Dube and Vargas (2013) argue that as military outlays rise, governments increasingly resort to external borrowing, which further raises debt burdens and reduces fiscal space. Such borrowing is often accompanied by conditionalities that prioritize debt servicing over socio-economic development, narrowing fiscal flexibility and deepening fragility. Beyond the fiscal dimension, military spending interacts with the political economy of conflict. Some scholars (e.g., Collier and Hoeffler, 2004) suggest that defense spending can deter violence and strengthen state capacity, while others caution that, under authoritarianism or neopatrimonial systems, militarization can entrench elite interests and fuel further instability (Bleaney and Greenaway, 2001). Thus, the impact of defense spending depends fundamentally on institutional quality and broader sociopolitical conditions.

Importantly, the temporal dynamics between defense spending and debt accumulation remain contested. Some studies argue that rising debt precedes increases in military expenditure as governments respond to heightened security threats (Dimitraki and Kartsaklas, 2018; Shahbaz et al., 2016). Others suggest the opposite: military spending itself drives external borrowing when domestic revenue falls short (Dimitraki and Kartsaklas, 2018; Dunne et al., 2019). This circularity complicates causal inference and challenges linear assumptions in conventional models. In fragile contexts, debt buildup may not only follow defense spending but also constrain future fiscal choices, feeding back into governance weaknesses and conflict. The inability to balance security needs with fiscal discipline deepens crises and points to the need for approaches that capture the endogenous feedback loops among debt, defense, and conflict.

Despite its relevance, empirical research on the military spending–debt–conflict nexus in Africa is limited and often fragmented. Most existing studies (e.g., Costa and Miranda, 2023; Makun, 2024; Okwoche and Nikolaidou, 2024) focus on individual countries, reducing generalizability. Methodologically, these studies largely rely on linear models like Pooled Mean Group estimators (Khan et al., 2021), fixed or random effects (Appiah-Kubi et al., 2022; Çolak and Özkaya, 2021; Dimitraki and Kartsaklas, 2018). Such approaches fall short in capturing dynamic feedbacks, threshold dynamics, and the role of governance quality in shaping fiscal and security outcomes.

To address these gaps, this study applies a dynamic nonlinear panel model to explore possible nonlinearities and regime shifts among military expenditure, external debt, and conflict intensity. We complement this with country-level time series regressions to capture individual country dynamics and apply panel Granger-causality tests to identify the temporal sequencing and direction of causality between debt and military spending. This approach advances the literature in three key ways. First, it offers comprehensive, up-to-date cross-country evidence on the dynamic interplay between military spending and debt accumulation under fragility. Second, it is among the first to jointly apply dynamic panel and time series analyses while accounting for nonlinear links. Third, it integrates institutional quality indicators to examine how governance moderates the debt–military–conflict relationship.

The study focuses on three core research questions: (1) How does military expenditure affect external debt accumulation in Africa's fragile states? (2) To what extent does defense spending reduce or intensify conflict in these countries? (3) Does debt accumulation precede defense outlays, or does military spending trigger new debt under conditions of fragility? By answering these questions, we aim to provide evidence-based insights that are relevant for fiscal and security policy. Specifically, we (i) quantify the fiscal impact of military spending on debt sustainability, (ii) assess whether defense expenditures help stabilize or destabilize fragile states, and (iii) identify the direction and strength of causality between debt and defense spending, emphasizing the moderating role of governance quality.

The analysis covers 2000–2023, a period of significant economic shifts, governance reforms, and heightened security challenges across SSA. Focusing on thirteen fragile states; characterized by chronic conflict, institutional

weakness, and high vulnerability to shocks, our study offers timely evidence for designing policies on debt sustainability, peacebuilding, and fiscal prudence.

The remainder of the paper is organized as follows: Section 2 reviews the empirical literature on military expenditure, debt, and conflict; Section 3 describes the data and methodology; Section 4 discusses empirical findings; and Section 5 concludes by pointing out major findings and ideas for policy.

2. Empirical Review

Globally, research increasingly points to a consistent pattern: military spending tends to worsen sovereign debt burdens especially under fragile conditions. Studies like Makun (2024), Shahbaz et al. (2016), and Dimitraki and Kartsaklas (2018), applying nonlinear ARDL, threshold, and structural break analyses, show defense expenditure as a long-run driver of debt accumulation. This effect arises not only through direct fiscal pressure but also because military budgets are often shielded during fiscal retrenchment, squeezing growth-enhancing public investment. Although these studies span diverse countries, they converge on the idea that military spending beyond certain thresholds accelerates debt build-up, creating lasting crowding-out effects.

Institutional and geopolitical factors emerge as critical moderators. Costa and Miranda (2023) and Montegary (2015) demonstrate that disciplined debt management, transparent fiscal systems, and tax-based defense financing can temper the debt impact of military expenditure. In contrast, Caruso and Di Domizio (2017) reveal how alignment with external defense commitments can shift debt burdens onto smaller economies, narrowing domestic fiscal space. Queralt (2019) supports tax-financed military outlays as more sustainable than debt-financed ones, offering longer-term capacity benefits rarely addressed in debt-focused models like Çolak and Özkaya (2021). Both Ahmed and Kamran (2017) and Çolak and Özkaya (2021) confirm that beyond fiscal thresholds, defense spending becomes contractionary and debt-intensifying.

A clear theme of nonlinear and asymmetric effects cuts across these works. Makun (2024) and Ghulam and Saunby (2024) find that moderate defense spending may stabilize fiscal conditions or reduce default risk, yet beyond certain points, it sharply raises debt distress. Solarin (2017) adds by showing recurrent military spending drives debt escalation more than capital investments. Evidence indicates debt–military nexus is rarely linear, subject to spending type, scale, and institutional capacity.

African research agrees on the debt-augmenting role of military outlays but shows that conflict intensity, governance weaknesses, and economic vulnerability deepen this effect. Dunne et al. (2019) and Khan et al. (2021) confirm that defense spending fuels debt growth in fragile SSA states mainly when conflict persists. Yet reliance on regional averages blurs national variations. Appiah-Kubi et al. (2022) and Asongu and Amankwah-Amoah (2018) go further by linking military spending to corruption and fiscal instability, although they often treat governance as exogenous, missing the feedback loops that embed governance failure into debt dynamics.

Methodologically, non-African studies more often use advanced techniques: FMOLS, DOLS, quantile regression, and threshold model. These methods capture how military spending interacts with institutional quality, geopolitical pressures, and global shocks. By contrast, African research mostly relies on first-generation estimators like PMG, BMA, or standard GMM, which, while statistically sound, struggle to detect tipping points and dynamic feedback effects that define debt sustainability under fragility. Despite these variations, a common view runs through both strands: military spending rarely remains fiscally neutral. It elevates sovereign debt, whether directly or by displacing investment in development sectors, particularly when financed through debt rather than taxes. Still, stronger institutions and tax-financed military budgets can offset these risks: a dynamic seen in Costa and Miranda (2023), but underexplored in Africa.

Few studies assess whether debt accumulation can precede military spending; a question highly relevant in fragile states that borrow preemptively amid rising threats. Equally, while the debt-raising effect of military outlays is widely confirmed, research rarely examines whether these expenditures effectively reduce conflict intensity or

instead deepen instability by diverting funds from inclusive development. African studies especially underexplore dynamic causality, regional spillovers, and external shocks, all increasingly relevant in a globalized defense economy. The literature shares three points: military spending generally augments sovereign debt; institutional and geopolitical contexts decisively shape this effect; and nonlinearities mean impacts shift dramatically beyond critical spending thresholds. In fragile African states, conflict persistence and governance deficits amplify these, creating a cycle where debt funds military budgets, which in turn sustain fragility and underdevelopment.

We address these by using dynamic nonlinear panel models to detect asymmetric and threshold effects linking military spending, external debt, and conflict intensity. We complement this with time series regressions to capture national-level patterns obscured in pooled data, and panel Granger causality tests to explore whether debt growth precedes military spending or vice versa: an angle not in prior work. By focusing on conflict-affected Africa, we integrate macroeconomic, defense, and institutional factors into a refined empirical model. We moves beyond confirming that military spending raises debt to clarify how, when, and under what conditions this emerges, providing fresh evidence of fiscal sustainability and security needs in Africa.

3. Materials and Methods

This section details the data and methodological aspects of the study. It outlines about sample selection, describes data source and key variables, and presents the empirical model specification used to analyze the dynamic links among military spending, external debt, and conflict intensity.

3.1 Sample Selection

We focus on thirteen fragile and post-conflict African states with severe governance deficits, weak institutional capacity, chronic socioeconomic crises, and persistent political instability and conflict Sarpong-Kumankoma et al. (2021). These states frequently rely on external borrowing to finance public spending, reflecting underdeveloped domestic revenue systems that, over time, deepen debt vulnerability (AfDB, 2023). Structural fragility further undermines debt servicing capacity, leading to sustained debt accumulation. Added to this are persistent macroeconomic instability and limited job creation, conditions that fuel cycles of armed conflict and social unrest, making these states a particularly relevant focus for this study.

Specifically, the sample comprises thirteen fragile and post-conflict African countries identified by the African Development Bank (AfDB, 2024), classified as fragile based on a Country Policy and Institutional Assessment (CPIA) score below 3, consistent with World Bank benchmarks. We selected the thirteen countries for which reliable and consistent data were available over the study period. Table 1 lists the full set of fragile states across Africa in our sample.

Table 1. Fragile & Post-Conflict African States Sampled

Country Name	Code	Country Name	Code
Burundi	BDI	Guinea Bissau	GNB
Central African Republic	CAF	Liberia	LBR
Chad	TCD	Sierra Leone	SLE
Congo, Democratic Republic	COD	Sudan	SDN
Congo, The Republic	COG	Togo	TGO
Côte d'Ivoire	CIV	Zimbabwe	ZWE
Guinea	GIN		

Source: AfDB (2024)

Note that this is not the exhaustive list of fragile economies in Africa; we have selected only some, but majority for which data are completely observed.

The temporal scope of this study spans from 2000 to 2023, as it marks the period when political and institutional quality indicators for all African economies are consistently and systematically reported.

3.2 Data Type and Source

We employ a blend of panel and time series observations to effectively achieve our broader objective. Precisely, the panel dataset is utilized to address two key aims: the dynamic influence of defense financing on sovereign debt and Granger causality test between the two principal variables. On the other hand, time series data are utilized to explore country-level dynamics in the link between military expenditures and conflict-induced internal displacements across the fragile states. This approach is necessitated by the fact that observations on conflict intensities are available only from 2009 onward, rendering the data insufficient for fitting dynamic panel modeling.

Accordingly, for each country in the panel, annual frequency secondary time series data on a range of macroeconomic, fiscal, financial, and institutional (governance) metrics were collected over a 24-year period (2000–2023) from the World Bank's World Development Indicators (WDI) and the International Financial Statistics (IFS). In addition to country-specific variables, the analysis incorporates the world interest rate series from the IFS to account for the influence of global financial system shifts on the indebtedness of African fragile states. We are providing in a while details of these indicators once completed the specification of empirical models in the next section.

3.3 Econometric Strategies

3.3.1 Nonlinear Dynamic Panel Model Specification

The relationship between military spending and external indebtedness requires an analytical approach that addresses multiple empirical issues at a time. First, the dynamic and persistent nature of sovereign debt demands the inclusion of its lagged terms to avoid dynamic panel bias and accurately capture debt motions. Second, the issue of endogeneity poses a critical threat to identification. Military expenditure can simultaneously drive and respond to external debt shifts, whether through direct fiscal channels or indirectly via security-development feedback loops (Knight et al., 1996). Conventional static estimators such as Fixed Effects (FE) and Random Effects (RE) models are incapable to address this, as they yield biased and inconsistent estimates when regressors are correlated with unobserved heterogeneity (Nickell, 1981). Third, the link between defense financing and indebtedness is unlikely to be strictly linear. At moderate levels, military investments may support political stability and improve debt sustainability; however, beyond a critical threshold, escalating militarization could exacerbate fiscal risks and precipitate unsustainable debt accumulation. Capturing such potential nonlinearities requires the explicit inclusion of a squared expenditure on military among regressors, following standard practices in macro-fiscal threshold analyses (Chandia et al., 2022; Sfakianakis et al., 2020).

To effectively address these issues, we estimate a nonlinear dynamic panel model using the System-GMM (Generalized Method of Moments) estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). System-GMM provides many advantages: (i) it effectively corrects for the bias introduced by the inclusion of lagged dependent terms; (ii) it addresses endogeneity concerns by employing internal instruments generated from lagged levels and differences of the regressors; and (iii) it remains consistent and efficient in panels with a relatively small number of cross sectional units and moderate time periods (Roodman, 2009).

Furthermore, in recognition of the risks of instrument proliferation that can weaken the validity of GMM estimators (Rohatgi and Syrgkanis, 2022), we adopt a conservative approach by limiting the number of instruments through matrix collapsing and restricting lag lengths, ensuring reliable inference from Hansen tests of overidentifying restrictions.

As has been made clear thus far, we capture potential nonlinearities in the link between military spending (MILTRY) and sovereign debt accumulation (DEBT), we set out a nonlinear dynamic panel data (DPD) model by

explicitly including MILTRY^2 term as an additional regressor. This allows the marginal effect of military finance to vary at different levels of spending, capturing possible nonlinear (e.g., U-shaped or inverted-U-shaped) effects, which are particularly relevant in economies severe institutional fragility and fiscal distresses (Judson and Owen, 1999).

The general form of the model is specified as:

$$\text{Debt}_{it} = \alpha \text{Debt}_{it-1} + \beta_1 \text{Miltry}_{it} + \beta_2 \text{Miltry}_{it}^2 + \gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where, Debt_{it} is the external debt-to-GDP ratio for country *i* at time *t*, Debt_{it-1} is the lagged dependent term to capture persistence in debt dynamics, Miltry_{it} is military expenditure-to-GDP ratio appearing alongside its squared term, X_{it} is a vector of additional controls (macroeconomic, fiscal, financial, and governance indicators), μ_i captures unobserved country-fixed effects ($\mu_i \sim \text{IID}(0, \sigma_\mu^2)$), λ_t are time-specific effects (to absorb common shocks), and ϵ_{it} ($\varepsilon_i \sim \text{IID}(0, \sigma_\varepsilon^2)$) is the idiosyncratic error term.

In the framework of (1), the total marginal effect of military spending on sovereign debt is

$$\frac{\partial \text{Debt}_{it}}{\partial \text{Miltry}_{it}} = \beta_1 + 2\beta_2 \text{Miltry}_{it} \quad (2)$$

Therefore, if $\beta_2 > 0$, the relationship is convex (U-shaped): the debt impact of military spending accelerates at higher levels, whereas for a negative value ($\beta_2 < 0$), the relationship turns concave (inverted-U-shaped): defense financing initially worsens debt but beyond a point its marginal effect reduces. This nonlinearity implies the possibility that small increases in military spending might enhance stability (e.g., through better security), but excessive militarization may strain public finances and worsen debt accumulation.

We estimate equation (1) by using System-GMM (Generalized Method of Moments) technique. The presence of lagged dependent variable Debt_{it-1} on the right-hand side introduces endogeneity due to its correlation with the fixed effects μ_i and the error term ϵ_{it}. Furthermore, military expenditures and other regressors may be endogenous or predetermined rather than strictly exogenous. Against this, we estimate the model using the System-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998).

System-GMM simultaneously estimates two equations. One is first-differenced equation to eliminate μ_i from equation (1)

$$\Delta \text{Debt}_{it} = \alpha \Delta \text{Debt}_{it-1} + \beta_1 \Delta \text{Miltry}_{it} + \beta_2 \Delta\left(\text{Miltry}_{it}^2\right) + \gamma' \Delta X_{it} + \mu_i + \Delta\lambda_t + \Delta\varepsilon_{it} \quad (3)$$

where lagged levels of the endogenous variables are used as instruments for their differences, and another is level equation to restore some of the lost information and improve efficiency, using its form as in equation (1).

Where lagged differences are used as instruments under the assumption that changes in the explanatory variables are uncorrelated with country-specific effects. The validity of System-GMM approach relies on two key sets of moment (identification) conditions**:** for level equation, valid instruments are lagged differences of the endogenous variables, whereas for first-difference equation, instruments are lagged levels of the endogenous variables.

Formally, the orthogonality conditions for appropriately chosen lags in System-GMM are:

$$\left.\begin{aligned} E\left[\text{Debt}_{it-s} \cdot \Delta\varepsilon_{it}\right] = 0, \qquad \text{for } s \geq 2 \\ E\left[\Delta \text{Debt}_{it-1} \cdot \left(\mu_i + \varepsilon_{it}\right)\right] = 0, \end{aligned}\right\} \quad (4)$$

Following standard practice, two diagnostic tests are conducted for instrument validity and specification tests. The Hansen J-test of overidentifying restrictions evaluates overall validity of the instruments, with a null hypothesis that instruments are valid, whereas the Arellano-Bond test for second-order serial correlation (AR(2)) inspects the absence of autocorrelation in the differenced residuals, where failure to reject the null (probability > 0.05) indicates a correctly specified model. In all estimations, we carefully maintain a finite instrument count by

collapsing instrument matrix (Roodman, 2009) to avoid the problem of instrument proliferation, which can otherwise bias the results.

3.3.2 Prais-Winsten Regression

To explore the impact of defense financing on conflict intensities at the country level, we employ the Prais–Winsten regression technique, a form of feasible generalized least squares (FGLS) that corrects for first-order serial correlation in the residuals (Vougas, 2021). Serial correlation is a common feature in time series data as past disturbances usually influence outcomes at present (Haile et al., 2025). Ignoring such autocorrelation risks inefficient results and biased inference.

Our starting point is the standard linear regression model:

$$y_t = \beta_0 + \beta_1 x_t + u_t \qquad \text{for } t = 1,2,...,T \tag{5}$$

where y_t is the measure of conflict intensity (number of internally displaced persons in our case), x_t denotes military expenditure as a share of GDP, and u_t is the error term.

Yet, in the presence of first-order autocorrelation, the error term u_t follows an AR(1) process:

$$u_t = \rho u_{t-1} + \varepsilon_t, \qquad |\rho| \tag{6}$$

where ϵ_t is a white noise error term. Here, ρ captures the degree of autocorrelation. Substituting the AR(1) error structure into the original regression model yields:

$$y_t = \beta_0 + \beta_1 x_t + \rho u_{t-1} + \varepsilon_t \tag{7}$$

Equation (7) implies that u_{t-1} is correlated with x_t depends on past shocks, violating the OLS assumption of zero correlation between explanatory variables and errors. Against this, Prais–Winsten transforms the entire model to remove serial correlation. The transformed variables for t = 2, …, T are defined as follows:

$$\left.\begin{aligned} y_t^* &= y_t - \rho y_{t-1} \\ x_t^* &= x_t - \rho x_{t-1} \end{aligned}\right\} \tag{8}$$

Thus, the transformed model becomes:

$$y_t^* = \beta_0 (1-\rho) + \beta x_t^* + \varepsilon_t \tag{9}$$

Interestingly, unlike Cochrane–Orcutt, Prais–Winsten also transforms the first observation (t =1) appropriately to avoid discarding valuable data. The transformation for the first observation is:

$$\left.\begin{aligned} y_1^* &= \sqrt{1-\rho^2}\, y_1 \\ x_1^* &= \sqrt{1-\rho^2}\, x_1 \end{aligned}\right\} \tag{10}$$

Correspondingly, the transformed first-observation model is:

$$y_1^* = \beta_0 \sqrt{1-\rho^2} + \beta_1 x_1^* + \varepsilon_1 \tag{11}$$

Prais–Winsten estimator then applies OLS to the transformed model across all t = 1, 2, … , T. ρ is unknown and must be estimated from the residuals of the original OLS regression, using the Durbin–Watson (DW) statistic or auxiliary regressions:

$$\hat{u}_t = \rho \hat{u}_{t-1} + \varepsilon_t \tag{12}$$

where, $\hat{u}_t$ are the OLS the residuals. After estimating ρ, the model is fully transformed and GLS estimation is applied to the transformed variables for efficient and unbiased estimates (Maeshiro, 1976).

Prais–Winsten is particularly advantageous here for several reasons. First, conflict intensities and military spending are both inherently persistent, resulting in autocorrelated disturbances that, if not corrected, would bias OLS results. Second, the time span for each series is relatively short (2009–2023), so conserving the first observation, as Prais–Winsten does, is vital to maintaining sample size and analytical precision. Third, given that

defense expenditure could respond to prior conflict outcomes, it is vital to control for dynamic feedback effects while maintaining efficient estimation. After Prais-Winsten estimation, the absence of residual autocorrelation is tested using the DW statistic

3.3.3 Panel Granger Causality Testing

One last objective in this research examines the causal link between external debt and military spending in fragile African states. Granger causality, in this context, refers to whether past values of one variable *X* contain predictive information about the current values of another variable *Y*, beyond the information contained in past *Y* values alone. Extending this concept to a panel data setting involves testing for causality across multiple cross-sectional units, countries in our case, observed over time. A panel Granger causality test therefore assesses whether $X_{i,t}$ Granger-causes $Y_{i,t}$, or conversely, whether $Y_{i,t}$ Granger causes $X_{i,t}$, where *i* indexes countries and *t* indexes time (year observations in this case.)

A basic specification for testing Granger causality in a panel framework is:

Equation (13): Testing *X*→*Y*

$$Y_{i,t} = \alpha_i + \sum_{p=1}^{P} \beta_p Y_{p,t-p} + \sum_{q=1}^{Q} \gamma_q X_{i,t-q} + \varepsilon_{it} \quad (13)$$

Equation (14): Testing *Y*→*X*

$$X_{i,t} = \alpha_i + \sum_{p=1}^{P} \delta_p X_{i,t-p} + \sum_{q=1}^{Q} \theta_q Y_{i,t-q} + \eta_{i,t} \quad (14)$$

where $Y_{i,t}$ and $X_{i,t}$, respectively, are dependent and independent variables for unit *i* at time *t*, α_i are country-specific fixed effects, β_p, γ_q, δ_p, ϑ_q are coefficients for lagged terms, and *P*, *Q* denote number of lags for *Y* and *X*, respectively. And, $\varepsilon_{i,t}$ and $\eta_{i,t}$ are the error terms. The null-hypotheses involved are therefore (1) H_0: $\gamma_q = 0\ \forall q$ (no causality from *X* to *Y*), and (2) H_0: $\theta_q = 0\ \forall q$ (No causality from *Y* to *X*).

We do have several methods to implement Granger causality in panel data. Homogeneous panel Granger causality assumes that the causal relationship (coefficients γ_q) is identical across all cross-sectional units. It is suitable when the panel is relatively homogeneous. In our case, panel units (fragile states) exhibit substantial asymmetry making this assumption irrelevant. The other is heterogeneous panel Granger causality. Incepted by Dumitrescu and Hurlin (2012), this allows for heterogeneity in the causal relationship across cross-sectional units. It tests a null hypothesis that there is no causality for any unit in the panel while allowing coefficients to vary. The Dumitrescu-Hurlin Granger causality test involves estimating:

$$Y_{i,t} = \alpha_i + \sum_{p=1}^{P} \beta_{i,p} Y_{i,t-p} + \sum_{q=1}^{Q} \gamma_{i,q} X_{i,t-q} + \varepsilon_{i,t} \quad (15)$$

It then computes average Wald statistic across units with a standardized test for inference.

Panel Granger causality has several advantages over pure time-series methods. By combining cross-sectional and time-series data, it increases statistical power, making it particularly effective for smaller time dimensions *T* when sufficient cross-sectional units *N* are available (Mutascu, 2016). In our case, the temporal scope (2000-2023) has 24 observations while the cross-sectional dimension covers 13 fragile states. However, this approach still is effective as the cross-sectional scope is above the minimum requirement of 10 (Diks and Panchenko, 2006). Additionally, panel methods consider unobserved heterogeneity through fixed or random effects, reducing potential bias in single-unit time series (Troster, 2018). It is this vigor that makes panel Granger causality tests super for causal inferences in panel analyses.

3.4 Variables Description and Measurement

In modelling the dynamic impact of military spending on sovereign debt accumulation across fragile African states through System-GMM estimation, we first anchor our model on external debt stocks (DEBT), measured as a percentage of Gross National Income (GNI). DEBT is a dependent variable, encapsulating the degree to which fragile states rely on foreign financing to meet fiscal and developmental gaps. Supposedly, higher external debt ratios imply either chronic fiscal deficits, large external imbalances, or, as posited by Reinhart and Rogoff (2010), systemic weaknesses in institutional capacity and governance. Under state fragility, external debt motions are especially subtle to both security shocks and global financial conditions.

A core regressor in our System-GMM specification, military expenditure (MILTRY), measured as a percentage of GDP, captures the fiscal burden imposed by defense-related outlays. Elevated defense financing is expected to exert upward pressure on sovereign debt. The logic is twofold: on one hand, fragile states often prioritize military as an instrument of regime security and power control (Collier and Hoeffler, 2009); on the other hand, such spending may crowd out productive investments, depress fiscal space, and support reliance on external borrowing. We then anticipate a positive link between defense financing and external debt, reflecting a "security-debt spiral" that traps fragile states in cycles of borrowing to sustain military control. By expressing military spending as a share of GDP, we account for the relative scale of defense budgets within gross income, allowing for meaningful comparisons across nations and over time.

GDP per capita growth (GDP) is incorporated to capture the effects of macroeconomic condition. Higher income growth rates should, in principle, reduce debt accumulation by expanding tax bases, improving fiscal revenues, and reducing sovereign risk (Barro, 1990). On the other hand, negative or stagnant growth may exacerbate fiscal pressures, forcing governments to seek external financing. Thus, an inverse link between GDP growth and foreign debt is posited, with higher growth expected to ameliorate debt burdens. Current account balance (CAB), given as a percentage of GDP, is another important macroeconomic factor of external indebtedness. Current account surplus provides countries with the foreign exchange necessary to finance domestic spending without resorting to foreign funds (Lane and Milesi-Ferretti, 2018). In fragile states, higher deficits tend to mirror weak export sectors, heavy import intensity, or remittance-driven consumption (Aromí, 2021). We hence expect a reducing effect of CAB herein: better external balances should diminish the need for external debt accumulation.

Population growth (POP), taken as an annual percentage, captures demographic pressures that are particularly acute in fragile states. Rapid population expansion rises demands for public services, infrastructure, and employment, thereby straining government budgets and exacerbating social fragility (Bloom et al., 2008). Thus, higher population growth is likely related positively with sovereign debt, as governments seek additional resources to meet escalating developmental and security demands.

We also control for personal remittances received (as a percentage of GDP), an increasingly significant external financial flow in fragile states. Remittances augment household incomes, contribute to foreign exchange reserves, and can indirectly reduce fiscal pressures by enhancing private consumption and investment (Ratha, 2013). Yet, they may also obscure underlying fiscal weaknesses if governments substitute private inflows for public investment. Clearly, remittances provide alternative sources of external income that can relieve fiscal and balance of payments gaps. As such, higher inflows may reduce the need for external borrowing, implying a negative possible contribution to external debt accumulation. But, as Abou Ltaif et al. (2024) recently discussed, when remittance-driven consumption substitutes for rather than complements public investment, the debt mitigating role could be limited.

World interest rates (WORRATE) are also introduced to capture the impact of global financial system on sovereign borrowing costs. Higher international rates raise the cost of foreign capital and are likely to increase the debt burden for fragile states, many of which have week bargaining power in world capital markets (Eichengreen

and Mody, 2000). This leads us to make a positive expectation into the impact of rising world rates on foreign indebtedness. Finally, regulatory quality (REGQLT), drawn from the WDI, captures the institutional aspect of debt sustainability. Strong quality regulations foster fiscal discipline, reduce corruption, and support more efficient debt management (Nguyen and Luong, 2021). Poor regulation is normally linked with wasteful spending, weak tax enforcement, and greater reliance on external borrowing (Gaiya et al., 2024). Note, however, that quality regulation can also build trust and confidence among foreign lenders, leading to a lower risk premium for borrowers and, as such, increased access to cheaper foreign funds (Fiordelisi et al., 2014). Therefore, the net effect cannot be determined a priori.

Though not included in the debt equation, conflict intensity (CONFL) is a crucial metric this study, a response variable in our country-level time series specifications. CONFL, measured by the number of internally displaced persons (IDPs) from conflict and violence, reflects the internal security status. Higher displacement indicate greater instability, which can simultaneously drive up defense spending and the needs for external borrowing (Becker, 2021).

As we consider reverse causality, the impact of defense finance on internal conflict intensity is more uncertain. While higher expenditure is intended to strengthen security, deter insurgencies, and restore state control (Collier and Hoeffler, 2004), in practice it favors fragility. As noted thus far, increased military budgets, especially under fragility, crowd out essential social spending, amplifying protests and undermining state legitimacy (Matallah, 2024). Again, defense spending here is marred by inefficiency, corruption, and politicization, weakening governance and eroding social contract (Hakvåg, 2017). Militarization can also empower factional groups, escalate arms explosion, and intensify violence, mainly in ethnically diverse areas. Without side investments in inclusive governance, economic opportunity, and institutional reform, rising defense budgets rarely translate into sustained peace (Asongu et al., 2019). In view of all these, defense financing alone tends not to buy peace but risks rooting cycles of insecurity and fiscal deterioration. Table 2 below summarizes these details about the variables.

Table 2. Variable Description

Variable	Notation	Measurement	Exp.
External Debt	DEBT	External debt stocks as a percentage share of gross national income (GNI).	DV
Military Finance	MILTRY	Military expenditure as a percentage of gross domestic products (GDP).	+
Economic Growth	GDP	GDP per capita growth as an annual percentage	–
Current Account Balance	CAB	Current account balance as a percentage of GDP	–
Remittance	REMT	Personal remittances received as GDP percentage	+/–
Population Growth	POP	Population growth rates per annum	+
World Interest Rate	WORATE	World lending interest rates per annum	+
Regulatory Quality	REGQLT	WB estimate capturing the ability of a government to formulate and implement sound policies and regulations that promote private sector development	+/–

4. Empirical Analysis

In this section, we present and discuss the empirical results in two main parts. First, we offer a descriptive analysis of the data, drawing on graphs and summary statistics to capture key patterns and provide an overview of the dataset. We then move to the inferential analysis; estimate a series of econometric models. We begin below by describing statistical features of the data.

4.1 Descriptive Insights into the Dataset

4.1.1 Statistical Summary

Table 3 presents a clear snapshot of the economic, political, and institutional landscape in Africa's fragile states over the past two decades. External debt stocks average a high 73.36% of GNI, with large cross-country differences and extremes like Liberia exceeding 600%, reflecting divergent borrowing strategies and repeated debt distress. Some countries manage moderate debt levels, while others remain heavily overleveraged, partly due to uneven fiscal responses to external shocks. Military expenditure averages about 1.95% of GDP, modest by global standards, but ranges widely from below 0.2% to nearly 8%. This spread reveals contrasting security issues: some governments channel significant resources to defense at the cost of development, while more stable states keep defense budgets contained. Conflict intensity further compounds fragility, as shown by annual average displacements exceeding 448,000 and peaks above six million in the worst-affected countries.

Table 3. Summary Statistics (2000-2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
DEBT	312	73.357	81.079	11.047	610.452
MILTRY	312	1.952	1.29	0.19	7.956
CONFL	90	448,918.39	958,879.6	94	603,9000
GDP	312	0.73	5.886	-36.778	27.831
CAB	312	-6.031	10.517	-65.257	28.827
POP	312	2.615	0.801	-0.077	5.785
REMT	312	3.129	4.158	0	21.81
WORATE	312	4.647	1.735	3.25	9.233
REGQLT	312	-1.165	0.341	-2.202	-0.116

Economic growth is similarly volatile: GDP per capita growth averages just 0.73%, swinging sharply between deep contractions and strong rebounds; typical of fragile, shock-prone economies. Current account deficits average -6.03% of GDP, often driven by structural trade gaps or periods of import-led growth. Population growth averages 2.6% yearly, adding pressure to already stretched social services and infrastructure. Remittances, averaging 3.13% of GDP and over 21% in some cases, remain vital safety nets despite uneven developmental impact. Global interest rates, averaging 4.65%, raise borrowing costs further for these already high-risk states.

Finally, regulatory quality is low, averaging -1.17, pointing to systemic institutional weaknesses that undermine policy implementation and private sector confidence. These statistics illustrate the deep-seated fragility that shapes debt dynamics and development outcomes across these states.

4.1.2 Debt-Military Spending Trends by Country

We hereby compare cross-country position in defense financing and external indebtedness over the last two and half decades between fragile African states. In Figure 1 below are the panel plots of military spending and foreign debt stocks across border. What emerges is a definitely different trend; foreign debt thoroughly dominates fiscal scenery, both in scale and volatility, compared to military spending.

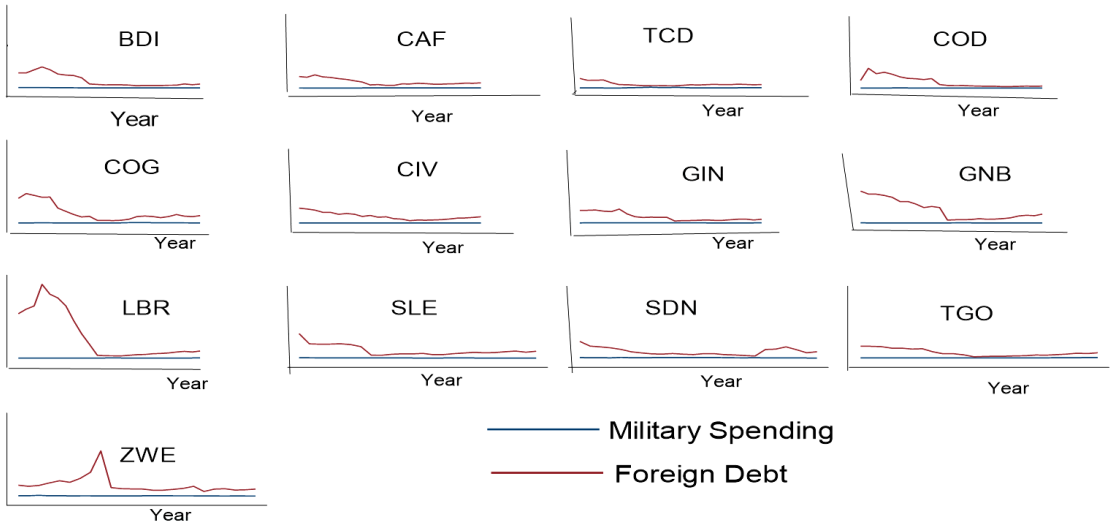

Figure 1. Panel Plots for Cross-Country Dynamisms in Debt-Military Nexus

As can be seen, for most countries, including Burundi, Central African Republic, Chad, Guinea, and Guinea-Bissau, military spending remains remarkably flat and low, barely registering on the same scale as the debt levels. This could indicate a limited fiscal space or perhaps donor-imposed ceilings on defense budgets. Yet, the relative passivity of military budgets contrasted with debt signals a reactive, but not proactive, fiscal stance in these economies: governments here appear to borrow in response to crises or development needs rather than to finance systemic military expansions.

Liberia and Zimbabwe present distinct cases. Liberia's spike in debt in the early 2000s aligns with post-civil war recovery and likely debt restructuring (Moran and Pitcher, 2004). Zimbabwe has seen a dramatic surge in foreign debt during its hyperinflation era and subsequent financial collapse, which is emulated in a brief spike in military spending. These signify a pairing of macroeconomic instability and conflict fragility: foreign debt escalates steeply even as military budgets rise only modestly in comparison. In both the Congo (DR and Republic), declining debt evinces certain debt relief or fiscal consolidation, possibly linked to multilateral initiatives like the HIPC program. Yet even here, military spending has not pointedly deviated, underscoring its insistent inertia across regimes. Interestingly, Congo Republic shows a mild upturn in both debt and military outlays, hinting at a dual expansion possibly due to resource rents or broader fiscal loosening. Sierra Leone, Sudan, TGO and Côte d'Ivoire exhibit relatively flatter patterns post-2010, likely from stabilization efforts or international budgetary discipline. Still, there is large imbalance between debt and military spending: external borrowing is the preferred tool of fiscal expansion while defense remains a marginal, yet politically sensitive, component.

A key observation across all panels is the weak synchrony between military spending and debt: even when debt spikes or falls, military budgets stay almost intact. This hints at a decoupling of fiscal strategies; debt is not being used to chiefly finance military, at least not in a visible or direct way. Several points emerge: debt-led fiscal expansion without corresponding increases in military budgets; a high degree of fiscal volatility via the debt channel; and a shared constraint in defense financing. These reflect both local governance and external factors, like aid dependency, conditionality, and military aid, influencing fiscal cycle in fragile economies (Haile et al., 2025).

4.1.3 Conflict-Induced Internal Displacement in Some Fragile States

Because most countries under study lack adequate temporal record on internal displacements related to political instabilities, we limit this analysis to only six states: Burundi, Central African Republic, Côte d'Ivoire, Congo DR, Sudan, and Chad.

Figure 2 portrays the temporal dynamics of conflict-induced internal displacement, taken here as the number of newly displaced persons due to conflict and violence, in these states. It captures the human cost of fragility, revealing patterns of volatility, escalation, and, in certain situations, sudden systemic tremors.

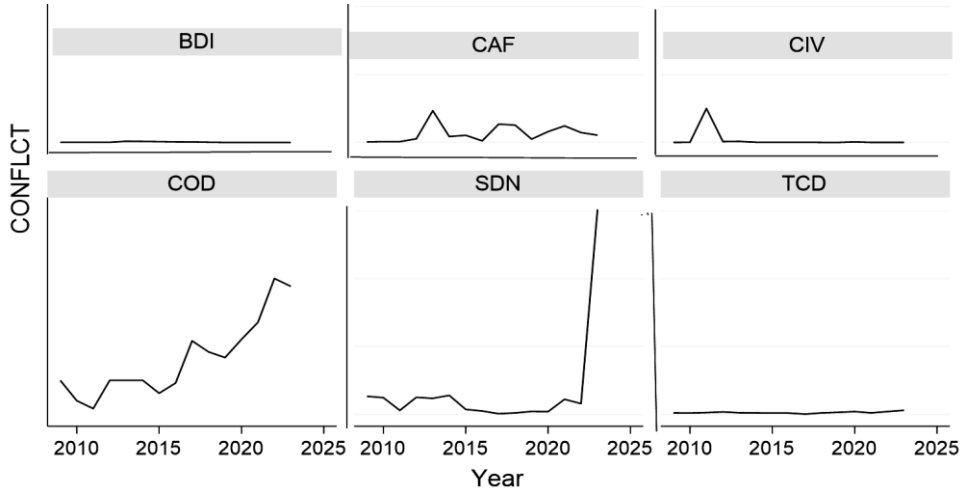

Figure 2. Conflict-Induced Internal Displacements in Selected Countries

Low yet persistent displacement levels have been observed in Burundi over the study period. This might reveal a chronically fragile setting with managed but never fully resolved conflict, often simmering at low intensity. Chad shows a comparable profile, markedly flat with marginal rises toward 2023, highlighting either the localization of conflict or its episodic, non-displacing nature. Central African Republic, by contrast, records more variability. Spikes in displacement around 2014 and intermittently thereafter correspond with well-documented events of civil war, sectarian violence, and peacekeeping interventions (Isaacs-Martin, 2021), which underscores the cyclicality of violence and the challenges in sustaining peace in post-conflict settings.

There is evidence of a significant spike around 2011 in Côte d'Ivoire, aligning with the post-election crisis that culminated in widespread violence and mass displacement (Charbonneau, 2012). What follows is a swift drop in the amount of internal displacement, signaling a return to political normalcy or, at least, the absence of mass conflict then after. Congo DR and Sudan situations are even more concerning. Large internal displacement post-2016 in Congo is a proof of harsh insecurity in its eastern provinces (Baroncelli, 2024); consistent with its rising foreign debt and spending on military (Figure 1). Sudan registers a critical upsurge post-2021 due to the upsetting conflict after the 2021 military coup and the 2023 armed confrontations between rival factions (Sapre and Singh, 2024). Exponential rise in displacement is not just a humanitarian cost but a fiscal and institutional one, with implications for governance, international involvement, and economic stability.

Evidence generally reveals the lived fragility across different conflict zones. While some states oscillate between stability and flare-ups (CAF, CIV), others exhibit chronic conflict escalation (COD, SDN), and still some others endure low-grade but continued unrest (BDI, TCD). These could inform linking conflict intensity to fiscal dynamics, governance distortion, or humanitarian dependency: core features of fragile statehood in Africa. This is to follow extensively next.

4.1.4 Comovement between Conflict Intensity and Military spending

Here we aim at grasping preliminary patterns in the joint evolution of defense financing and conflict-induced internal displacements in six fragile states. Literally, higher expenditure should correspond with reduced conflict, as defense budgets are ostensibly meant for enhancing security and deterring violence. Panel plots in Figure 3 portray these trends by country over time with an initial visual impression.

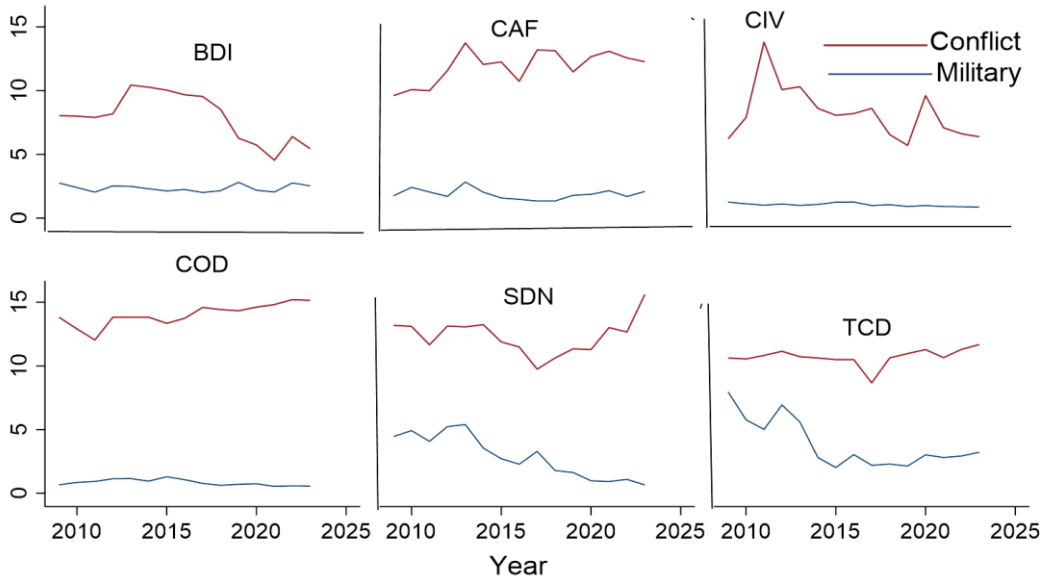

Figure 3. Conflict Intensity versus Defense spending by Country (2009–2023)

Across all the six states, conflict intensities consistently exceed military expenditures over 2009–2024: militarization has not succeeded in quelling internal unrest during the period. In Congo DR and Sudan, where conflict intensities remain persistently high and relatively stable, the minimal variation in military spending implies that defense budgets are not responding systematically to security issues. On the other hand, Côte d'Ivoire saw a noticeable drop in conflict levels from a high in the early 2010s, alongside a relatively flat path in military spending. Conflict resolution in Côte d'Ivoire may have been based more on political clearings and institutional reforms rather than defense outlays. Chad presents an interesting case; both variables demonstrate declining trends until a moderate uptick post-2020. Accordingly, peace in Chad is more likely to be an economic rather than a military factor; inclusive growth can reduce both violence and thus the amount of resource meant for security. Addressing socio-economic grievances as a route to conflict resolution is a key way out from permanent fragility.

4.2 Inferential Analysis

The inferential analysis of the relationship between foreign debt and defense financing begins with System-GMM estimation of a dynamic panel model. This is followed by a Prais-Winsten regression to assess the impact of defense spending on conflict intensity, and subsequently a panel Granger-causality test for the directionality between debt and defense financing. Before proceeding to model estimation, we first address some basic diagnostics.

4.2.1 Panel Unit Root Testing

Unit root testing is foundational among the pre-estimation checks, even though System-GMM is relatively robust to nonstationarity, as it informs the order of integration and guards against spurious inferences. While unit root issues can undermine traditional panel estimators, System-GMM accommodates potential nonstationarity using internal instruments derived from own lag structure, reducing dependence on strict stationarity assumptions (Blundell and Bond, 1998). Its moment conditions are valid even when the level variables follow stochastic trends, provided that first-differenced errors are uncorrelated (Roodman, 2009). As such, although stationarity is desirable, System-GMM maintains consistency in many realistic macroeconomic panels where full stationarity is difficult to guarantee. Ensuring the stationarity properties of the panel data thus is a critical step in establishing the credibility of our inference. But still, stationarity is important to avoid spurious results and inflated

test statistics (Roodman, 2009). Particularly in macro panels with persistent trends, nonstationarity can bias moment conditions and weaken instrument validity, as noted in Bond (2002). Thus, preliminary unit root test and transformation is prudent steps in panel GMM.

We apply both the Levin, Lin, and Chu (LLC) and Im, Pesaran, and Shin (IPS) panel unit root tests by Levin et al. (2002) and Im et al. (2003) to examine the stationarity properties of our dataset. They were chosen for their complementary strengths: LLC assumes a common unit roots process across cross-sections while IPS allows for individual unit root trends. Both consistently indicated that all series are stationary, thereby confirming the absence of unit root issues in our panel data. These ensure the reliability of our dynamic specification and justify the use of System-GMM in our case. The full set of these results is found in Table 4 below.

Table 4. Panel Unit Root Test Results

Variable	Levin–Lin–Chu	Im-Pesaran-Shin
DEBT	-3.8805***	-3.9122***
MILTRY	-3.2020***	-2.4626***
GDP	-5.9752***	-7.4130***
CAB	-5.1132***	-2.6253***
POP	-6.0054***	2.8061***
REMT	-3.7386**	-1.98**
WORATE	-8.3623***	-5.5633***
REGQLT	-2.9105**	-2.0434***

***, **, & * represent statistical significance at the 1%, 5%, % 10% levels, respectively.

Note, the fixed-N exact critical values for IPS are -2.070 (1%), -1.900 (5%), and -1.820 (10%), while the LLC test decisions are based on the default probabilities evaluated at the 5% levels. Accordingly, no series in a panel set has failed each test.

4.2.2 Select Specification Check

An essential step in validating the variables used in our analysis is testing for multicollinearity. While multicollinearity does not pose a direct concern in System-GMM estimation, it remains relevant given the broader scope of our analysis, which includes multiple supplementary model specifications. To assess potential collinearity, we use both simple pairwise correlation analysis and Variance Inflation Factors (VIF). The results are presented in Table 5.

Table 5. Multicollinearity Test

	DEBT	MILTRY	MILT-sq	GDP	CAB	POP	REMT	WORATE	VIF
MILTRY	-0.11								4.22
MILT-sq	0.08	0.64							3.06
GDP	-0.16	-0.11	-0.08						1.22
CAB	-0.04	0.02	0.01	0.05					1.14
POP	0.02	0.04	0.06	0.24	-0.06				1.13
REMT	-0.08	-0.22	-0.18	0.11	-0.21	-0.16			1.07
WORATE	0.39	0.00	-0.00	-0.06	0.08	0.08	-0.23		1.07
REGQLT	-0.27	-0.03	-0.04	0.13	0.3	0.09	-0.01	-0.07	1.03
Average VIF									1.74

Interestingly, the pairwise correlation coefficients all lie below the commonly accepted threshold of 0.4, indicating a low risk of multicollinearity, except to the squared term of military spending, which registers a correlation of 0.64 with its linear component. This is anticipated given their inherent mathematical relationship

and does not create a serious analytical concern. Furthermore, VIFs for all individual variables are clustered around 1, with the military spending variable and its squared term taking values of 4 and 3, respectively: still well below the conventional cutoff of 10. Hence, multicollinearity is not a significant issue in our specification, thereby supporting the statistical validity of the variables employed in our analysis.

4.2.3 Estimating Dynamic System-GMM Model

We proceed to estimate a dynamic panel model using the System-GMM model for the impact of military finance on debt. Our use of System-GMM is informed by its ability to address potential endogeneity, unobserved heterogeneity, and dynamic feedback inherent in our data (Blundell and Bond, 1998). In addition, to ensure the robustness of our results, we also estimate the model using Difference-GMM approach by Arellano and Bond (1991), which, though less efficient under persistent series, can be a good benchmark. As shown in Table 6, results across both estimators are closely aligned in terms of size, direction, and statistical significance, lending credence to the reliability and validity of our core findings. Throughout our discussion thus, we refer exclusively to System-GMM as our benchmark given its superior efficiency and robustness with persistent variables and potential endogeneity.

Table 6. Empirical GMM Estimates

	System-GMM			Difference-GMM		
	Coef.	t-value	Prob.	Coef.	t-value	Prob.
DEBT(L1)	0.866***	38.30	0.000	0.832***	24.31	0.000
MILTRY	-0.011	-1.26	0.209	-0.009	-1.32	0.187
MILTRY_sq	0.197**	2.28	0.024	0.492***	2.98	0.003
GDP	-0.488**	-2.26	0.025	-0.530**	-1.99	0.047
CAB	0.043	0.27	0.786	0.206	1.13	0.260
POP	0.184**	2.29	0.023	0.618***	4.41	0.000
REMT	-0.496	-1.17	0.244	-0.459	-1.38	0.166
WORATE	0.937***	7.98	0.000	0.915***	10.33	0.000
REGQLT	0.358*	1.79	0.073	0.351*	1.66	0.098
Arellano-Bond AR(1) Test =	-1.16(0.028)					
Arellano-Bond AR(2) Test =	0.48(0.630)					
Sargan Overiden. Rest. Test =	105.94(0.078)					
Hansen Overiden. Rest. Test =	3.16(0.290)					
No. of Obs.=	299					
Wald =	12.83(0.30)					

***,**&* denote statistical significance at the 1%, 5% and 10% levels, respectively; Numbers in parenthesis are probability values

A key observation from Table 6 is strong persistence in external debt, as shown by the highly significant and positive lagged coefficient on $DEBT_{t-1}$(0.866). This is in line with expectations in highly indebted fragile economies where past debt stocks tend to be self-reinforcing, reflecting both rollover behavior and institutional constraints in managing long-term fiscal sustainability.

Turning to the focal variable of interest, military expenditure (MILTRY), its direct effect, though trivial, is negative, suggesting that, on its own, current military spending does not systematically contribute to foreign debt accumulation in the short run. Yet, the squared term (MILTRY_sq.) introduces a non-negligible nonlinear pattern. Its significantly positive estimate (0.197) implies a convex bond: while moderate military spending may not profoundly influence debt levels, higher levels of spending could begin to exert an upward pressure on external debt. This curvilinear link supports views that beyond a certain threshold, fiscal burden of defense becomes

unsustainable, prompting fragile governments to resort to foreign financing of such expenditures (Çolak and Özkaya, 2021).

In addition to this, GDP per capita growth makes a significant negative association with external debt. Economic growth can ease debt burdens through enhancing revenue capacity and reducing the need for external financing by fragile governments. Population growth (POP), conversely, makes a positive and significant impact on debt accumulation, likely capturing the demographic pressure placed on public resources and the consequent need for greater fiscal outlays, some of which may be debt-financed. Excitingly, current account balance (CAB) and remittance inflows (REMT) appear to be weak predictors in this specification. Estimated values for both metrics prove statistical insignificance: for fragile states, both external flows may be either too volatile or too marginal relative to defense expenditure needs to exert consistent pressure on debt. World lending interest rate (WORRATE), yet, stands out with a highly significant and dominant contributor (0.937, $p < 0.01$), pointing to the substantial influence of global financial conditions on African debt profiles. Thus, shifts in global interest rates can quickly amplify debt burdens in economies of interest through increased servicing costs.

Finally, regulatory quality (REGQLT) emerges as a marginally important predictor (0.358, $p = 0.073$), with a positive sign. Although not robust at the conventional 5% level, this may suggest that improvements in governance and institutional quality are associated with greater borrowing capacity, perhaps through facilitating better access to credit markets, but could also indicate that donors and creditors are more willing to extend loans to countries perceived as reforming.

In general, debt profile in fragile African states is subject not only to economic fundamentals but also intricately linked to the strategic allocation of military resources and the influence of global finance. Nonlinearity in the military-debt nexus is particularly noteworthy; while defense outlays may be justified on grounds of security or political stability, their unchecked expansion risks undermining fiscal sustainability. A more calibrated approach is required to defense budgeting; supported by sound macroeconomic management and institutional strengthening, to ensure that borrowing remains within sustainable bounds.

But, how does our study compare to the broader literature? Let’s re-visit the findings herein with parallels from previous scholarship.

We found a non-negligible convex association between military outlays and external debt growth in fragile African states. This is similar to the nonlinear mechanisms uncovered in Makun's (2024) analysis for Fiji, which likewise revealed asymmetries in how military budgets shape debt dynamics. His emphasis on policy biases, favoring domestic debt consolidation while external liabilities grow, is instructive here. Fragile states across the continent, facing limited tax bases and donor conditionality, may parade similar biases, shifting the burden of military financing externally once domestic fiscal space tightens. A notable debt inertia, moreover, aligns closely with Dimitraki and Kartsaklas (2018) and Shahbaz et al. (2016), where witnessed similar debt persistence in Greece and Pakistan, respectively. Especially Shahbaz et al. (2016), document large contribution from military expenditure to inefficient resource allocation. Such inefficiency is corroborated in our negative and significant coefficient for GDP growth; with elevated military burden, even modest economic expansions may not translate into reduced debt, perhaps due to rigidities in fiscal programming or limited absorptive capacities.

A positive population-debt linkage in our model further echoes the fiscal mechanism outlined by Çolak and Özkaya (2021) with defense-related fiscal burdens escalating as demographic or geopolitical stressors mount. Though they focused on post-Cold War transitions, the fiscal stress threshold concept travels well to Africa, where demographic expansions strain underdeveloped infrastructure and public services, increasing the likelihood of debt-financed military or social spending. Ghulam and Saunby (2024) complement this by arguing that while moderate military expenditure may stabilize sovereign risk, crossing a threshold reverses this trend; precisely the turning point hinted at by our non-trivial MILTRY_sq term.

Additionally, the irrelevance of remittance inflows and current account balances herein draws parallels with Queralt (2019), critiquing the overly debt-focused tale in military fiscal studies for overlooking how tax or remittance-financed security finance might affect fiscal sustainability. In fragile African situations, unstable remittance flows or aid-dependent current accounts may fail to exert stabilizing effects on debt precisely because they lack institutional embeddedness or are offset by defense-oriented outlays, as similarly cited in Nagou et al. (2021). A robustly positive impact of global interest rate on African indebtedness is arguably one of the most policy-salient results of ours. This reflects geopolitical asymmetries noted by Caruso and Di Domizio (2017) where European debt burdens were heavily swayed by U.S. defense plans and interest rate cycles. In fragile African, external rate shock hikes also heightens debt accumulation especially when compounded by non-discretionary military financing imperatives due to regional security threats. This result features the broader critique advanced by Montegary (2015).

A broader elucidation of regulatory quality, with marginal significance in our case, also demands a brief reading. While better regulations may enhance borrowing capacity or improve debt terms, as Costa and Miranda (2023) cite for Portugal, they may also mend efficiency in defense spending: turning what would otherwise be debt-augmenting outlays into more sustainable fiscal moves. However, as the findings of Appiah-Kubi et al. (2022) and Ekouala (2023) imply, the effect of governance on debt is not uniform across Africa; without explicit interactions between military spending and institutional quality, the results may mask deep heterogeneity.

Ultimately, our findings support the hypothesis that military expenditure influences debt trails in fragile states in a nonlinear, contextual way. Convexity in military-debt relationship, combined with strong global rate dependence and demographic pressures, reinforces the view championed by Asongu and Amankwah-Amoah (2018) and Okwoche and Nikolaidou (2024) that any credible debt sustainability model must take into account security-development nexus and its embedded institutional and geopolitical dimensions.

4.2.4 Are Defense Finances Buying the Peace?

One of the core empirical motivations of this study is to test whether fiscal expansions through militarization are effective in reducing internal conflict in fragile African states. To do so, we apply both panel and time series regression using from 2009 onwards and limited to six countries for which consistent conflict data are available as such information is missing for more than half of the sample.

Due to the limited size of the panel, both on space and temporal dimensions, it is not feasible to work with more robust dynamic panel econometrics. As such, we adopt the baseline FE and RE models to get initial insights into the nexus between defense and conflict intensities. Table 7 next presents the results from both models alongside key diagnostics.

Table 7. RE and FE Regression Results

	RE			FE		
	Coeff.	t-value	Prob.	Coeff.	t-value	Prob.
MILTRY	-0.124	-0.85	0.395	0.043	0.27	0.788
DEBT	-0.031**	-2.22	0.026	-0.019	-1.41	0.162
GDP	-0.054	-1.56	0.119	-0.072**	-2.33	0.023
REGQLT	-0.602***	-2.72	0.008	-0.571**	-2.58	0.012
Hausman Test:	chi2(4) = 21.21(0.0003)					
No. of obs. =	90					
Prob F (FE)	0.000					
Prob Wald (RE)=	0.000					
R_sq (FE) =	0.525					
R_sq (RE) =	0.422					

*** & ** suggest significance at 1% and 5% levels, respectively; Source: Authors' own Estimation.

The Hausman test (p = 0.0003) clearly rejects the null hypothesis of orthogonality in favor of FE estimator in our specification. It implies that unobserved heterogeneity across borders correlates with the regressors and must be controlled for through country-specific fixed effects. It is within this FE specification that the most policy-relevant interpretations lie herein.

Military spending appears to be statistically irrelevant in both RE and FE models. Interestingly, while RE suggests a negative, albeit weak, effect (-0.124), FE flips the sign to positive (0.043). The point is clearer: defense finance alone is not effective to influence conflict dynamism in any systematic way across fragile African states. This is consistent with Collier and Hoeffler (2004), arguing in fragile conditions that, the efficacy of military budgets depends more on governance, accountability, and security sector reform than on absolute spending levels. Foreign debt, on the other hand, is significant under RE (p = 0.026) but loses statistical support under FE (p = 0.162). It is hence possible that country-invariant institutional or structural factors confound the link between debt and conflict in cross-sectional comparisons, but within-country dynamics over time give a more tempered view. Yet, the consistently negative sign supports the typical concern that external debt burdens when unaccompanied by productive investment or relief mechanisms can indirectly fuel unrest by limiting fiscal space and swelling economic insecurity (Kaya, 2021).

By contrast, GDP per capita growth reveals a more robust influence under the FE specification (-0.072, p = 0.023). Upturns in economic performance within nations over time enticingly dampen conflict intensity, aligning with ideas of opportunity cost of rebellion. When legitimate economic opportunities expand, people are less likely to engage in or support violence (Wayne Nafziger and Auvinen, 2002). Empirically, Ferguson et al. (2019) also note that sustained, inclusive economic growth is one of the most effective structural reins to civil conflict.

As it should be, regulatory quality holds the most consistent and significant impact across both specifications: significant at the 1% level under RE (-0.602, p = 0.008) and at the 5% level in RE model (-0.571, p = 0.012). This underpins a foundational truth in conflict economics: institutions matter. Better regulatory environs: those featured by transparency, rule enforcement, and policy reliability, pointedly reduce the level of internal displacement and violence. Fragile states with better governance scores experience marked reductions in violence and displacement, regardless of the size of expenditures on defense.

A key message is transmitted here. Military spending, absent institutional reform, appears largely useless in addressing root causes of conflict in Africa. Instead, it is the quality of governance and inclusive economic growth that matter the most to ensure sustainable peace and security.

From Table 7, the estimates on military spending are consistently insignificant does not necessarily imply that they are irrelevant across all the individual countries within a panel. Rather, they play only trivially on average in mitigating conflict-related crisis over there. In an economy of smart regulation and people-focused growth model, a fraction of the resource allotted to military sector should be associated with positive security outcomes. In simple language, defense financing can a significant influence in some, not all, of the fragile states in our sample. We empirically do this by subsequently estimating six time series models, each one for the six fragile states for whom data on internal conflict intensity are observable, using Prais-Winsten regression. Table 8 below indicates the corresponding model outputs by country.

A particularly striking result is suggested in Congo DR; military expenditure exerts a significant and robust positive effect on conflict intensity (-0.622, t = -4.00). This finding aligns with views that increased militarization in fragile situations often exacerbates conflict rather than containing it, mainly when military budgets are weakly aligned with institutional accountability and civilian oversight (Croissant and Lorenz, 2018). In the other states, the effect of military finance is trivial, albeit negative: while its presence may reflect a deterrence motive, its actual success in reducing conflict is not upfront and highly contextual.

Table 8. Country-Level Results: military finance-conflict nexus

	Prais-Winsten					
	BDI	CAF	TCD	COD	CIV	SDN
MILTRY	-0.575	-1.109	-0.237	-0.622***	-0.264	-0.536
	(-0.62)	(-1.48)	(-1.44)	(-4.00)	(-0.10)	(-1.41)
DEBT	-0.287**	-0.068	-0.028	-0.019	0.028	-0.031
	(-2.95)	(-0.91)	(-0.50)	(-1.58)	(0.59)	(-1.10)
GDP	0.328	-0.139***	0.094**	-0.071	-0.301***	-0.121
	(1.54)	(-4.73)	(2.51)	(-1.34)	(-4.86)	(-0.64)
POP	-0.030	-0.049	-0.853***	-0.207	-0.901	-0.149*
	(-0.04)	(-0.22)	(-4.17)	(-1.06)	(-1.42)	(-2.13)
REGQLT	0.672*	-0.339*	0.748**	0.857***	-0.756***	0.635
	(2.03)	(-2.00)	(3.23)	(3.94)	(-3.73)	(0.08)
Probability(F)	0.003	0.004	0.014	0.001	0.000	0.043
R_sq.	0.676	0.850	0.787	0.894	0.871	0.430
DW(Adjusted)	2.23	2.33	1.95	2.14	1.89	1.86
No. of obs	14	14	14	14	14	14

***, **, & * denote significance at 1%, 5% and 10% levels, respectively. In parenthesis ( ) are t-values; Source: Authors' Estimation.

Analyzing external debt, we see a statistically significant and negative effect in Burundi (-0.287, *t* = -2.95), that higher debt burdens are associated with intensified conflict. Some argue that debt grief in fragile states can strain fiscal capacity, limit social spending, and thus contribute to social unrest (Pierson, 1998). This trend, however, is not consistently significant across the other states, revealing the uneven macro-fiscal vulnerabilities across them. Growth in GDP per capita delivers a more exciting trend. In Chad, for instance, it is positively associated with conflict intensity (0.094, *t* = 2.51), somewhat counterintuitive. This could imply the "resource curse" motion: economic growth, if dominated by extractive sectors, may actually heighten conflict due to elite competition for rents (Chachu and Nketiah-Amponsah, 2022). On the contrary, in Côte d'Ivoire and the Central African Republic, income growth negatively correlates with conflict.

Population growth makes strongly significant association with conflict intensity in Chad (-0.853, *t* = -4.17) and weakly significant in Sudan (-0.149, *t* = -2.13). These observations are against the usual expectations, where demographic pressures on scarce resources and rising unemployment are common precursors to instability in low-income nations. Across all countries, population is negative in influence regardless of size and significance, which needs further exploration.

The most conceptually rich intuition may stem from the result on regulatory quality. In Central African Republic and Côte d'Ivoire, as expected, improvements in regulatory quality notably mitigate conflict, whereas in Congo DR, Chad, and Burundi, even higher regulatory quality may be insufficient or possibly distorted by elite capture or uneven enforcement. As such, in the latter states, governance effectiveness, and not just its formal institutions, determines developmental outcomes. In its 2024 report (Dilip et al., 2023), the World Bank reiterates this distinction, warning that regulatory gains in fragile states often mask poor institutional legitimacy on the ground.

By now, it should be clear that defense financing alone is neither a panacea for peace nor an upfront cause of conflict. Its effectiveness appears to be mediated through broader institution, economics, and demographics. Cross-country asymmetries suggest specific, rather than uniform, policy responses.

4.2.5 External Debt: Leading or Following Military Expenditure?

One further motivation in this study is whether external debt stocks lead or respond to changes in military budgets across fragile African states. We achieve this by using the Dumitrescu and Hurlin (2012) panel Granger

non-causality test that is especially suited for heterogeneous panels. The associated regression outputs are found in Table 9.

Table 9. Panel Granger non-Causality Test Results

Null-hypothesis	W-bar	Z-bar	Z-bar tilde	Decision
Defense Finance does not Granger-cause Debt Growth	3.625	6.693*** (0.000)	5.294*** (0.000)	Reject
Debt Growth does not Granger-cause Defense Finance	3.149	5.480*** (0.000)	4.292*** (0.000)	Reject

*** is rejection of the null hypothesis at 1%; figures in parenthesis ( ) are probability values; Source: Authors' Estimation.

These results illustrate the dynamic interrelationships between military expenditure and external debt buildup in fragile states of Africa. We found robust bidirectional Granger causality between the two, that military spending and external debt are mutually reinforcing in these economies.

We have in the first panel a W-bar statistic of 3.625 with the standardized Z-bar and Z-bar tilde statistics at 6.693 and 5.294, respectively. All linked probabilities are well below 1%, decisively rejecting the null hypothesis of no causality. Hence, past trends in military spending considerably predict future paths of external debt accumulation. This empiric is consistent with fiscal response theory; fragile governments, constrained by weak revenue bases and under pressure to maintain internal security, disproportionately rely on external borrowing to fund defense outlays (Collier and Hoeffler, 2004). Recent evidence from Kpodar et al. (2023) similarly file security-related shocks as inducing higher public borrowing in poor nations, especially where institutional checks are weak and military is prioritized over productive investments. In Africa, thus, militarization may be a prime factor of fiscal stress, worsening indebtedness despite no balancing reforms or external concessional support.

Equally important is the reverse causality observed in the second panel. The null hypothesis once again is rejected with a W-bar of 3.149, and Z-bar and Z-bar tilde statistics of 5.480 and 4.292, respectively, all statistically significant at conventional levels. As such, external debt motion can itself affect future military spending decisions. Several mechanisms may underlie this feedback loop. Governments may adjust military budgets in line with donor conditionalities emphasizing security sector reforms (e.g., IMF, 2019), or in anticipation of geopolitical bargaining over aid and strategic rent-seeking (Khan et al., 2021). Additionally, as external debt servicing crowds out other productive expenditures, governments may protect military to ensure their survival, mostly in fragmented polities with contested sovereignty. The latter makes impressive sense to Africa as much of its governments have their leadership models set with dictatorial rule.

Our results generally support a fiscal-security spiral within Africa's fragile parts: a feedback loop where debt-financed militarization drives further debt accumulation, and rising indebtedness supports militarized policy priorities. This confirms the theoretical framing advanced by Hendrix (2010), arguing that in institutionally poor regions, the military functions not only as a public good but also as a political instrument for elite consolidation and resource extraction: a good description of Africa.

5. Conclusion

Debt accumulation in fragile African states is driven less by development needs than by security-led fiscal strategies, weak institutions, and external shocks. Using dynamic panel modelling with System-GMM, Prais–Winsten regressions, and panel Granger-causality tests, we find dynamics often overlooked. Most notably, there is a nonlinear effect: while moderate military spending may seem manageable, crossing a critical threshold turns it into a major fiscal burden. Results here also challenge the view that higher military spending alone brings peace. Instead, lower conflict intensity is more closely linked to better governance, regulatory quality, and sustained

economic growth. Higher incomes increase the opportunity cost of conflict, and accountable institutions act as real stabilizers. Without these foundations, large defense budgets become costly and ineffective.

We also find a self-reinforcing "fiscal–security trap": debt fuels higher military spending, which in turn drives further borrowing. In many fragile states, the military extends beyond defense to political and economic roles, but this approach proves unsustainable, shrinking development space and raising vulnerability to external shocks like rising interest rates. This evidence points to the need to shift from security-led fiscal models to growth-oriented, institutionally grounded strategies.

Policy measures should follow these insights. Countries could set strategic caps on defense spending linked to economic conditions, supported by fiscal rules, transparent procurement, and independent oversight. Debt sustainability models should treat military spending as a structural liability, while lenders could tie support to growth-focused sectors such as health, education, and infrastructure. Stronger tax systems and resource management would help reduce reliance on external debt. Finally, lasting peace requires more than military spending. Investments in judicial independence, anti-corruption, and inclusive governance have proven effective in reducing conflict and improving fiscal stability. Development partners can support this by linking security aid to governance reforms, and regional cooperation can help identify risks early and share what works.

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