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GOVERNMENT EXPENDITURE AND TRADE BALANCE IN SUB-SAHARAN AFRICA

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----------ABSTRACT----------
This study investigates the relationship between government spending and trade balance in Sub-Saharan Africa from 2005 to 2022 using an autoregressive distributed lags (ARDL) model and balanced World Bank panel data. The findings reveal a significant short- and long-term association between the variables. A 10% rise in government spending results in a 6.3% short-term trade balance decline but a 30.9% improvement in the long run, illustrating a J-curve effect. Cointegration and Granger causality tests confirm a stable, causal relationship. The study recommends strategic spending policies to mitigate short-term deficits and boost long-term trade performance.
KEY WORDS: *Government expenditure, Trade Balance, Sub-Saharan Africa*----------

INTRODUCTION

Trade balance, a critical indicator of economic health, reflects the difference between a nation's exports and imports. In Sub-Saharan Africa (SSA), persistent trade deficits have been a defining economic characteristic, spanning over five decades. These deficits, attributed to structural issues such as heavy reliance on raw material exports, low industrial capacity, and high dependency on imports, pose significant challenges. They erode foreign exchange reserves, exacerbate external debt burdens, and hinder sustainable growth (World Bank, 2022; IMF, 2022).

The relationship between government expenditure and trade balance has drawn growing attention in addressing these deficits. Public spending, particularly on infrastructure and productive sectors, can influence trade dynamics by boosting domestic production capacity and export competitiveness. However, in the short term, increased government expenditure often drives higher import demand, exacerbating trade imbalances. Despite the critical role of fiscal policies, there is limited empirical evidence on their direct impact on trade balance in SSA, especially in the context of recent economic challenges such as fluctuating commodity prices and external shocks (OECD, 2021; AfDB, 2022).

This study aims to explore the relationship between government expenditure and trade balance in SSA from 2005 to 2022, employing the auto regressive distributed lags (ARDL) model. The analysis seeks to identify both short- and long-term effects, contributing to a deeper understanding of fiscal policy's role in trade dynamics. The findings are expected to guide policymakers in formulating evidence-based strategies to reduce trade deficits and enhance macroeconomic stability in the region.

LITERATURE REVIEW

Trade balance dynamics have been a subject of extensive research globally, with studies examining the interplay between fiscal policy, macroeconomic stability, and trade performance. Keynesian economics posits that increased government expenditure stimulates aggregate demand, potentially widening trade deficits in the short term. However, endogenous growth theories argue that well-targeted public investments, such as in infrastructure and human capital, enhance productivity and export competitiveness, reducing trade imbalances over time (Barro, 1990; Romer, 1986). Empirical studies from advanced economies like the United States and Germany reveal a mixed relationship, where

the impact of government spending on trade balance depends on the structure of the economy and the type of expenditure (Corsetti & Müller, 2006; Blanchard, 2007).

In SSA, persistent trade deficits have been attributed to low industrial diversification, over-reliance on commodity exports, and significant import dependency. Regional studies highlight that increased government expenditure often leads to a short-term increase in imports due to infrastructure and industrial project demands. However, in the long run, strategic investments in export-oriented industries and technology can improve trade balance (AfDB, 2022; IMF, 2021). For instance, infrastructural improvements in East African nations have shown a positive impact on export performance, though initial deficits were exacerbated by high import content during the construction phase (World Bank, 2020).

At the country level, studies in Uganda, Kenya, and Nigeria illustrate the nuanced effects of government spending on trade balance. For example, research in Uganda found that public expenditure in agriculture improved export performance, while investments in non-tradeable sectors like real estate widened trade deficits (Mugume, 2019). In Nigeria, ineffective fiscal management and corruption diluted the benefits of public expenditure, leading to sustained trade imbalances (Adeniran & Yusuf, 2020). These findings underscore the importance of expenditure targeting and governance in shaping trade outcomes.

This study is grounded in two key theories: the twin deficit hypothesis and the J-curve theory. The twin deficit hypothesis suggests that fiscal deficits, often driven by increased government expenditure, directly correlate with trade deficits by raising domestic demand for imports (Corsetti & Müller, 2006; Blanchard, 2007). This relationship arises from the interplay between fiscal policy and external borrowing, as increased spending without corresponding revenue generation often leads to a rise in external debt and a worsening trade balance (AfDB, 2022; IMF, 2021).

The J-curve theory complements this by explaining the temporal dynamics of trade balance adjustments. It posits that government expenditure initially worsens the trade balance due to heightened import demand but gradually improves it as public investments boost productivity and exports (Mugume, 2019; Romer, 1986). The combination of these theories provides a comprehensive explanation of the short- and long-term effects of government expenditure on trade balance in Sub-Saharan Africa.

CONCEPTUAL FRAMEWORK

The conceptual framework defines the trade balance (dependent variable) as a function of government expenditure (independent variable). In the short term, increased government expenditure amplifies import demand, exacerbating trade deficits, consistent with the twin deficit hypothesis (Corsetti & Müller, 2006; Adeniran & Yusuf, 2020). In the long term, however, such expenditure if directed toward productive sectors enhances export capacity, improving trade balance in line with the J-curve theory (AfDB, 2022; World Bank, 2020).

DATA AND METHODS

This study adopts a quantitative research design to analyze the relationship between government expenditure and trade balance in Sub-Saharan Africa from 2005 to 2022. The auto regressive distributed lags (ARDL) model is employed due to its effectiveness in examining both short- and long-term dynamics, particularly when variables have different integration orders (Pesaran et al., 2001). The ARDL model is particularly well-suited for economic research where data stationarity varies across countries and time periods.

The sample consists of 20 Sub-Saharan African countries (Appendix 10), selected based on the availability of data from the World Development Indicators database (World Bank, 2023). This selection represents a diverse range of economies, capturing different patterns of government expenditure and trade balances within the region. The independent variable is government expenditure, while the dependent variable is the trade balance.

The ARDL model is specified as follows:

$$TB_{it} = \alpha_0 + \sum_{p-1}^{k} \alpha_p \Delta TB_{i(t-p)} + \sum_{p-1}^{k} \beta_q \Delta GEX_{i(t-q)} + \gamma TB_{i(t-1)} + \delta GEX_{i(t-1)} + \varepsilon_{it} \quad \ldots\ldots\ldots(1)$$

Where;

TB_{it}: Trade balance for country i at time t

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GEX_{it}: Government expenditure for country i at time t
Δ: First difference operator
$\alpha_p$and β_q : Short-term coefficients
γ and δ: Long-term coefficients
ε_{it} : Error term. (Green, 2012)

Dependent Variable: Trade Balance (TB), measured as exports minus imports in absolute terms TB = (|X - M|), reflects the difference between a country's exports (X) and imports (M) and is a key indicator of a nation's economic health and external sector performance (Krugman, Obstfeld, & Melitz, 2018; Salvatore, 2016).
Independent Variable: Government expenditure (GEX), General government final consumption expenditure (current US$) (World Bank 2022).

The conceptual framework of this study investigates the relationship between government expenditure (independent variable) and trade balance (dependent variable) within Sub-Saharan Africa. Both short- and long-term effects are modeled using ARDL and cointegration techniques to capture the dynamic relationships between the variables. Unit root tests, such as the Augmented Dickey-Fuller and Phillips-Perron tests, are conducted to assess the stationarity of the data (Dickey & Fuller, 1981; Phillips & Perron, 1988).

The ARDL model's capacity to handle variables with mixed levels of integration and its suitability for small sample sizes make it an ideal choice for this study (Nkoro & Uko, 2016). The use of secondary panel data from a reliable source ensures the study's robustness by enhancing generalizability of the results.

To determine the long-term relationship between the variables, the Pedroni Residual Cointegration test is used (Pesaran et al., 2001), confirming the existence of cointegration between government expenditure and trade balance. Model selection criteria such as the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) are employed to ensure optimal model specification (Nkoro & Uko, 2016). These criteria assist in selecting the best-fitting model by balancing complexity and goodness of fit.

RESULTS

Descriptive statistics provide insights into the central tendencies and variability of the study variables. Key statistics for LNTB (trade balance) and Government expenditure (LNGEX) are summarized in Appendix 1. The average value for LNTB (22.723) suggests moderate levels of trade balance, while LNGEX has a lower average (5.120), indicating economic variability across the sample countries over the study period. The high standard deviation of LNGEX (3.130) relative to its mean reflects substantial differences in economic output among the countries, while the lower standard deviation for LNTB (1.303) suggests relatively less variability in trade balance.

The positive skewness for LNTB (0.608) implies a right-skewed distribution, indicating that most countries have lower trade balances, with a few exhibiting significantly higher values (Asongu, 2014). On the other hand, the higher skewness for LNGEX (1.666) indicates a pronounced right skew, where most values are clustered at lower LNGEX levels, and a few countries have significantly higher economic output.

Both variables exhibit leptokurtic distributions, as shown by kurtosis values greater than 3 (LNTB = 3.596, GEX = 8.783), indicating frequent occurrences of extreme values (Pesaran et al., 2001). The Jarque-Bera test results confirm significant deviations from normality, with probabilities of 0.000001 for LNTB and 0 for LNGEX. This suggests non-normal distributions for both variables, with GEX exhibiting a more extreme departure from normality due to its higher skewness and kurtosis (Bahmani-Oskooee & Alse, 1993; Rose, 2015).

These descriptive insights underscore the importance of addressing data variability and non-normality in the econometric modeling process, particularly for LNGEX, where the deviations are more pronounced.

Auto Regressive Distributed Lags (ARDL) model results (Appendix: 5)

$$\widehat{TB}_{it} = 9.193122 - 0.250152TB_{i(t-2)} - 0.633988GEX_{i(t-2)} + 3.090721GEX_{i(t-1)} \quad \ldots\ldots\ldots(2)$$

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Auto Regressive Distributed Lag (ARDL) model analysis reveals a significant relationship between government expenditure and trade balances in Sub-Saharan Africa. Key findings are as follows:

The constant term (9.193122) represents the baseline trade balance when government expenditure and other variables are constant. This positive value suggests that, without changes in government expenditure, the trade balance would remain at approximately 9.19 units, reflecting a long-term equilibrium when external factors are not affecting it.

The short-run coefficient of government expenditure is negative (-0.633988), implying that a 10% increase in government expenditure leads to a 6.3% deterioration in the trade balance. This indicates that Sub-Saharan countries face short-term challenges in adjusting their trade balances in response to government spending fluctuations.

Similarly, the short-run coefficient of the lagged trade balance is negative (-0.250152), meaning a 10% increase in the previous period's trade balance leads to a 2.5% decline in the current trade balance. This suggests that past trade performance has a negative impact on current trade balance outcomes, indicating some inconsistency in how trade balances adjust over time.

In contrast, the long-run coefficient is positive (3.090721), indicating that a 10% increase in government expenditure results in a 30.9% improvement in the trade balance over time. This supports the J-curve hypothesis, where initial trade deficits worsen due to lags in adjustments, but long-term improvements occur as exports become more competitive.

The Pedroni Residual Cointegration test (Appendix 7) confirms a long-term relationship between government expenditure and trade balance, suggesting a stable equilibrium over time. Despite the variables being integrated at different orders (I(1) and I(0)), the test results do not reject the null hypothesis of no cointegration, validating the ARDL approach as effective for analyzing both short- and long-term dynamics.

Diagnostics indicate that the standard error of regression (0.080409) is significantly lower than the standard deviation of the dependent variable (0.163355), suggesting that the model adequately explains the variations in the trade balance. Information criteria (Akaike Information Criterion, Schwarz Criterion, and Hannan-Quinn Criterion) are minimal, signaling an optimal fit for the model. Unit root tests (Appendices 2, 3, and 4) confirm that the variables are stationary at different integration orders, addressing potential non-stationarity issues.

Normality, heteroskedasticity tests (Appendix 6 & 9 respectively) show no significant deviations, affirming the reliability of the ARDL model. The findings align with the J-curve hypothesis, demonstrating that while trade balance deteriorates in the short run due to immediate adjustments, it improves over time as economies adjust to changes in government expenditure. These results underscore the importance of designing adaptive trade policies that mitigate short-term economic impacts while taking advantage of the long-term benefits of increased government expenditure. Granger causality test (Appendix 8) rejects the null hypothesis, indicating that government expenditure has a causal effect on trade balance.

DISCUSSION

Results of this study provide valuable insights into the relationship between government expenditure and trade balance in Sub-Saharan Africa, confirming some theoretical expectations while offering unique findings.

The study's findings on the short-term effects of government expenditure on trade balance align with earlier research. Specifically, the negative short-run relationship between government expenditure and trade balance (-0.633988) mirrors the results of Bahmani-Oskooee and Alse (1993), who suggested that increased government spending often exacerbates trade deficits in the short term due to heightened domestic demand, which typically leads to increased imports. This observation is also supported by Asongu (2014), who found similar outcomes in Sub-Saharan African economies, highlighting the sensitivity of trade balances to fiscal policy shocks.

The J-curve hypothesis, which suggests that trade balances worsen initially before improving in the long term due to adjustments in export competitiveness, is confirmed by the positive long-run coefficient of government expenditure (3.090721). This is consistent with previous studies, such as Pesaran et al. (2001), which documented a similar long-

term relationship in their analysis of macroeconomic variables and trade balances in various economies. The results suggest that while government expenditure might temporarily worsen the trade balance, over time, it fosters conditions conducive to improved trade performance as export sectors adjust.

The study's use of the Pedroni Residual Cointegration test is a noteworthy contribution, confirming the existence of a long-term equilibrium relationship between government expenditure and trade balance, despite differences in the integration order of the variables. This reinforces the effectiveness of the ARDL model in capturing both short- and long-term dynamics, a feature that has been lauded in previous research (Pesaran et al., 2001; Nkoro & Uko, 2016).

A unique aspect of this study is the clear indication that past trade performance negatively influences the current trade balance, as evidenced by the negative short-run coefficient of the lagged trade balance (-0.250152). This suggests that past trade imbalances might carry forward and hinder current efforts to balance trade, a phenomenon not widely discussed in the existing literature on Sub-Saharan Africa. The negative persistence in trade balances could be attributed to structural factors such as trade dependency, inefficiencies in export sectors, and slow adaptation to shifts in government expenditure policies.

Additionally, the study provides a comprehensive examination of the data's distributional properties, with descriptive statistics revealing non-normality in key variables such as government expenditure (GEX). The pronounced right skewness and leptokurtic distributions found in this study are consistent with the findings of Pesaran et al. (2001) and Rose (2015), who also observed non-normality in economic variables in similar settings. The study also highlights how these statistical properties can affect the robustness of econometric models and the interpretation of results, an issue often overlooked in prior studies.

From a policy perspective, these results emphasize the need for Sub-Saharan African countries to adopt more adaptive trade and fiscal policies. While government expenditure may initially increase trade deficits, the long-term benefit such as improved export competitiveness can enhance trade balances if the economy is structured to capitalize on these effects. This insight is critical for policymakers who need to balance short-term fiscal stimulus with long-term growth objectives. The findings suggest that careful management of government expenditure, alongside strategic investments in export-driven industries, can help mitigate the adverse short-term effects on trade balances while fostering long-term trade stability.

In conclusion, this study provides strong evidence of both short-term and long-term relationships between government expenditure and trade balance in Sub-Saharan Africa, contributing to the existing literature by confirming the J-curve hypothesis and identifying the persistence of past trade imbalances as a unique feature. The results underscore the importance of comprehensive economic policies that address both immediate and structural factors in improving trade balances across the region.

LIMITATIONS

While this study provides valuable insights into the relationship between government expenditure and trade balance in Sub-Saharan Africa, several limitations must be acknowledged that may have affected the findings and their interpretation.

One of the primary limitations of this study is the reliance on panel data approach, which, while beneficial for capturing both short-term and long-term dynamics, is inherently limited by the available data. The Auto Regressive Distributed Lag (ARDL) model, though robust for handling mixed integration orders, assumes that the relationships between variables are linear and stable over time (Pesaran et al., 2001). In reality, economic relationships may be non-linear and subject to abrupt structural changes, especially in a region as diverse as Sub-Saharan Africa, where political instability, external shocks, and policy changes can alter economic dynamics (Nkoro & Uko, 2016). This assumption may limit the ability of the ARDL model to fully capture the complexities of the underlying relationships.

The study focuses on 20 Sub-Saharan African countries selected based on data availability from the World Bank Development Indicators database. While this sample provides useful insights, it may not fully represent the diversity of economic systems, political environments, and institutional frameworks across the region. Sub-Saharan Africa comprises over 40 countries, each with unique trade regimes and fiscal policies, and the exclusion of certain countries

with limited data may lead to sample bias (Asongu, 2014). Furthermore, the choice of countries based on data availability may not reflect the broader economic realities of all Sub-Saharan African nations, potentially affecting the generalizability of the results.

The study relies on secondary data from the World Bank, which, while comprehensive, is subject to the limitations of data accuracy, consistency, and timeliness (World Bank, 2023). In many Sub-Saharan African countries, data collection systems can be inadequate, leading to discrepancies or gaps in the data, particularly for macroeconomic indicators such as government expenditure and trade balance (Rose, 2015). This could introduce measurement errors, which may affect the reliability of the results. Additionally, the use of annual data, while standard in macroeconomic studies, may not capture the more granular fluctuations within a year that could affect the dynamics between government expenditure and trade balance (Pesaran et al., 2001).

While the ARDL model is appropriate for analyzing the relationship between government expenditure and trade balance, it also has limitations. The ARDL approach assumes that the long-run relationship between variables is stable, but in reality, such stability may be disrupted by external shocks, changes in government policies, or shifts in global economic conditions (Nkoro & Uko, 2016). Moreover, the study does not account for potential endogeneity issues, where reverse causality or omitted variable bias could influence the results. While the Granger causality test helps mitigate this, it may not fully capture all potential causal relationships between the variables.

Additionally, the use of unit root tests such as the Augmented Dickey-Fuller and Phillips-Perron tests, while standard, may not be sufficient to detect all forms of non-stationarity, particularly in small samples or when the data exhibit structural breaks (Dickey & Fuller, 1981; Phillips & Perron, 1988). Therefore, while the study finds evidence of a stable long-term relationship, there is still a possibility that underlying dynamics could change over time, especially in response to unforeseen macroeconomic shocks.

The ARDL model assumes that the relationship between government expenditure and trade balance is symmetric and does not account for potential asymmetries in how these variables interact under different economic conditions. For example, the effect of government expenditure on trade balance might differ during periods of economic growth versus periods of recession (Bahmani-Oskooee & Alse, 1993). Additionally, while the Pedroni Residual Cointegration test is useful for detecting long-term relationships, it does not capture short-run dynamics in the same detail as other cointegration tests, such as the Johansen test (Pesaran et al., 2001). This may limit the scope of understanding regarding the full range of short-term adjustments between government spending and trade balances.

CONCLUSION

This study provides a comprehensive analysis of the relationship between government expenditure and trade balance in Sub-Saharan Africa, utilizing an Auto Regressive Distributed Lag (ARDL) model to explore both short- and long-term dynamics. The key findings indicate that while government expenditure has a negative short-term effect on trade balance, it promotes long-term improvements, consistent with the J-curve hypothesis. This suggests that while the initial response to increased government spending may worsen the trade balance, the long-run benefits manifest as economies adjust, increasing competitiveness and stimulating exports (Asongu, 2014; Rose, 2015).

The study also highlights the importance of considering both short-term and long-term impacts when formulating economic policies in Sub-Saharan Africa. Policymakers should account for the transitional period where trade balances may worsen before showing signs of improvement. This reinforces the need for adaptive trade policies that can help mitigate the adverse short-term effects while positioning economies to capitalize on the long-term benefits of increased government expenditure.

The results underscore the complexity of the trade balance dynamics in Sub-Saharan Africa, where multiple factors, including government spending, influence trade performance. The findings also stress the importance of implementing policies that not only foster immediate fiscal adjustments but also support structural transformations that can drive long-term trade balance improvements (Nkoro & Uko, 2016; Pesaran et al., 2001).

While the study offers valuable insights, limitations related to data availability, model assumptions, and the sample size must be acknowledged. Future research could extend this study by incorporating more granular data, expanding

the sample to cover all Sub-Saharan African countries, and exploring alternative modeling approaches to capture the potential non-linear relationships and external shocks affecting trade balances. Moreover, additional variables, such as exchange rate volatility and global trade policies, could provide a more nuanced understanding of the factors influencing trade balance outcomes in the region.

Ultimately, the findings of this study contribute to the broader discourse on fiscal policy and trade balance dynamics in developing economies, particularly in Sub-Saharan Africa. The results are particularly relevant for policymakers aiming to design sustainable fiscal policies that balance short-term adjustments with long-term economic growth and trade stability.

RECOMMENDATIONS

The study highlights the short-term negative effects of government expenditure on the trade balance. Policymakers should design fiscal policies that consider the delayed response of trade balance to government spending. It is recommended that governments in Sub-Saharan Africa adopt strategies that balance short-term fiscal expansion with long-term sustainability, such as targeted investments in sectors that directly enhance export competitiveness and trade balance. To leverage the long-term positive effects of government expenditure on trade balance, governments should prioritize export-oriented policies. Investments in infrastructure, technological innovation, and export diversification will help boost the competitiveness of Sub-Saharan economies, making them more resilient to the initial negative impacts of fiscal expansions. This aligns with the findings supporting the J-curve hypothesis, where export performance improves in the long term despite short-term deterioration (Asongu, 2014; Rose, 2015).

Given the study's findings on the time lag for trade balance adjustments, trade policies should be adaptive and consider the transitional periods. Policies aimed at stabilizing trade balances in the short term (such as import substitution or trade facilitation programs) could help mitigate negative impacts while long-term export growth is nurtured.

Governments should invest in strengthening the institutional frameworks that govern fiscal policy and trade. Building stronger institutions will enhance the efficiency of government spending and the implementation of trade policies that stimulate long-term economic growth. Programs aimed at improving the technical capacity of trade and finance ministries could ensure better policy coordination and implementation.

The study supports the idea that long-term improvements in the trade balance are linked to government spending on export-promoting infrastructure. Programs that target transportation, energy, and technological infrastructure are essential for making exports more competitive, especially in the global market. Programmatic support should focus on reducing trade barriers and lowering logistical costs to improve the efficiency of trade flows.

While this study utilized the ARDL model, future research should explore non-linear relationships between government expenditure and trade balance, especially considering the possibility of threshold effects or structural breaks. Other advanced econometric methods, such as panel smooth transition regression (PSTR), may offer deeper insights into the complex dynamics of fiscal policies and trade balances (Nkoro & Uko, 2016).

Future studies should consider the impact of global factors such as commodity price fluctuations, exchange rate volatility, and external economic shocks, which can affect the trade balance in Sub-Saharan Africa. Including variables like oil prices, global demand, and international trade agreements could provide a more comprehensive understanding of trade balance dynamics.

Expanding the study to include a broader set of Sub-Saharan African countries would improve the generalizability of the findings. Research that considers the diverse political, economic, and social environments across the region can offer more tailored recommendations for different types of economies within Sub-Saharan Africa.

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APPENDICES

Appendix 1: Descriptive statistics

	LNTB	LNGEX
Mean	22.72312	21.25134
Median	22.66982	21.27345
Maximum	26.29797	25.14656
Minimum	20.05782	18.25531
Std. Dev.	1.303215	1.397874
Skewness	0.608428	0.579542
Kurtosis	3.596138	3.758312
Jarque-Bera	27.54177	28.77768
Probability	0.000001	0.000001
Sum	8180.323	7650.482
Sum Sq. Dev.	609.7144	701.5045
Observations	360	360

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Appendix 2: Unit root test, LNTB (in Level)

Panel unit root test: Summary
Series: LNTB
Date: 12/04/24 Time: 13:53
Sample: 2005 2022
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.10733	0.0000	20	320
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.31145	0.0005	20	320
ADF - Fisher Chi-square	70.6565	0.0020	20	320
PP - Fisher Chi-square	90.7962	0.0000	20	340

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Appendix 3: Unit root test, LNGEX (in Level)

Panel unit root test: Summary
Series: LNGEX
Date: 12/04/24 Time: 13:51
Sample: 2005 2022
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.23265	0.0000	20	320
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.95703	0.1693	20	320
ADF - Fisher Chi-square	46.6574	0.2176	20	320
PP - Fisher Chi-square	58.2962	0.0308	20	340

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

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Appendix 4: Unit root test, LNGEX (in First difference)

Panel unit root test: Summary
Series: D(LNGEX)
Date: 12/04/24 Time: 13:54
Sample: 2005 2022
Exogenous variables: Individual effects
User-specified lags: 1
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.96981	0.0000	20	300
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-7.50685	0.0000	20	300
ADF - Fisher Chi-square	129.987	0.0000	20	300
PP - Fisher Chi-square	212.010	0.0000	20	320

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Appendix 5: Auto Regressive Distributed Lags (ARDL) model results

Dependent Variable: D(LNTB)
Method: ARDL
Date: 12/04/24 Time: 14:00
Sample: 2010 2022
Included observations: 260
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): D(LNGEX)
Fixed regressors: C
Number of models evalulated: 16
Selected Model: ARDL(3, 4)
Note: final equation sample is larger than selection sample

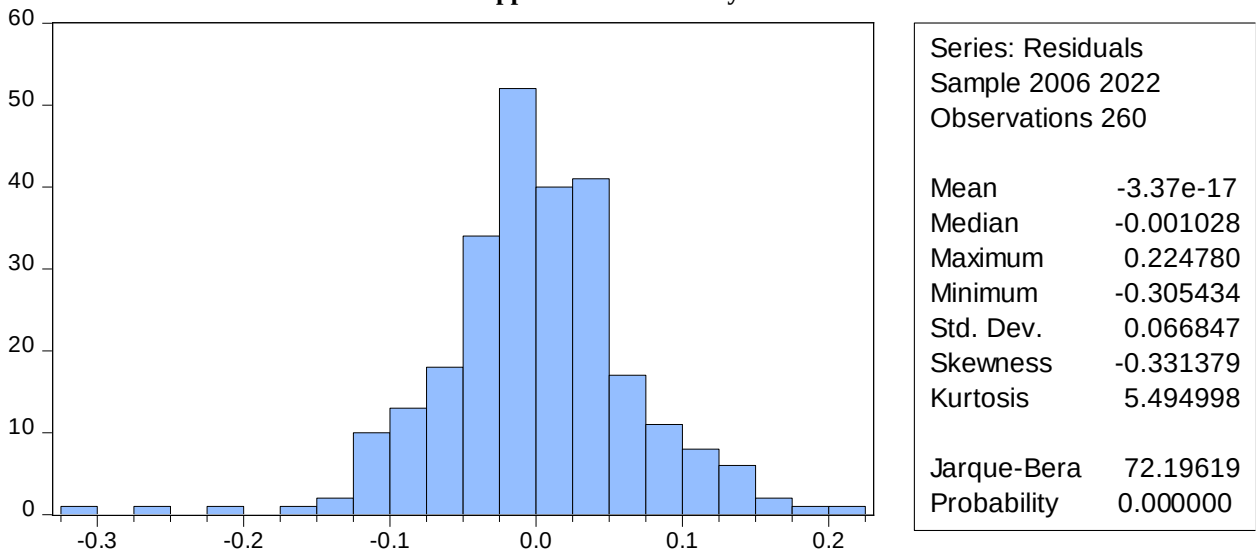
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
D(LNGEX)	3.090721	0.075568	40.89961	0.0000
Short Run Equation				
COINTEQ01	-0.394067	0.074777	-5.269880	0.0000
D(LNTB(-1))	0.123151	0.073529	1.674865	0.0957
D(LNTB(-2))	-0.250152	0.085773	-2.916440	0.0040
D(LNGEX,2)	-0.633988	0.183235	-3.459968	0.0007
D(LNGEX(-1),2)	-0.325466	0.147216	-2.210804	0.0283
D(LNGEX(-2),2)	-0.127586	0.093627	-1.362713	0.1747
D(LNGEX(-3),2)	-0.121886	0.060598	-2.011383	0.0458
C	9.193122	1.745098	5.267970	0.0000

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Mean dependent var	0.050132	S.D. dependent var	0.163355
S.E. of regression	0.080409	Akaike info criterion	-1.310639
Sum squared resid	1.157342	Schwarz criterion	0.502479
Log likelihood	383.8086	Hannan-Quinn criter.	-0.588188

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 6: Normality test



Appendix 7: Cointegration test

Pedroni Residual Cointegration Test
Series: LNTB LNGEX
Date: 12/04/24 Time: 14:10
Sample: 2005 2022
Included observations: 360
Cross-sections included: 20
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	2.341213	0.0096	1.678413	0.0466
Panel rho-Statistic	-1.850868	0.0321	-1.389602	0.0823
Panel PP-Statistic	-4.015723	0.0000	-3.065343	0.0011
Panel ADF-Statistic	-4.884931	0.0000	-4.153046	0.0000

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.468791	0.6804
Group PP-Statistic	-2.913342	0.0018

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Group ADF-Statistic	-4.036958	0.0000

Cross section specific results

Phillips-Peron results (non-parametric)

Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
Angola	0.757	0.029426	0.029426	0.00	17
Benin	0.238	0.019666	0.019666	0.00	17
Burkina Faso	0.834	0.012000	0.020131	2.00	17
Cabo Verde	0.318	0.021059	0.012009	6.00	17
Gambia, The	0.722	0.014157	0.015561	1.00	17
Kenya	0.634	0.008797	0.010402	1.00	17
Madagascar	0.316	0.020154	0.005150	8.00	17
Mali	0.283	0.008588	0.009860	2.00	17
Mauritania	0.598	0.019984	0.019984	0.00	17
Namibia	0.652	0.008890	0.008890	0.00	17
Niger	0.751	0.008133	0.010340	2.00	17
Rwanda	0.445	0.006359	0.005720	2.00	17
Senegal	0.367	0.004994	0.004110	3.00	17
Seychelles	0.688	0.019544	0.015339	7.00	17
Sierra Leone	0.257	0.042771	0.045527	1.00	17
South Africa	0.166	0.008263	0.004174	7.00	17
Tanzania	0.523	0.013251	0.013251	0.00	17
Togo	0.762	0.006807	0.010142	2.00	17
Uganda	0.291	0.045315	0.018932	16.00	17
Zambia	0.265	0.038749	0.031861	2.00	17

Augmented Dickey-Fuller results (parametric)

Cross ID	AR(1)	Variance	Lag	Max lag	Obs
Angola	0.615	0.027535	1	--	16
Benin	0.235	0.020417	1	--	16
Burkina Faso	0.733	0.009091	1	--	16
Cabo Verde	0.018	0.014253	1	--	16
Gambia, The	0.679	0.014686	1	--	16
Kenya	0.574	0.008686	1	--	16
Madagascar	-0.048	0.015385	1	--	16
Mali	0.509	0.007251	1	--	16
Mauritania	0.438	0.015762	1	--	16
Namibia	0.594	0.008088	1	--	16
Niger	0.693	0.008329	1	--	16
Rwanda	0.161	0.005204	1	--	16
Senegal	0.251	0.005148	1	--	16
Seychelles	0.583	0.016173	1	--	16
Sierra Leone	0.161	0.043328	1	--	16
South Africa	-0.227	0.007248	1	--	16
Tanzania	0.528	0.013850	1	--	16
Togo	0.658	0.005583	1	--	16
Uganda	-0.060	0.036321	1	--	16
Zambia	0.154	0.040025	1	--	16

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Appendix 8: Granger Causality tests

Pairwise Granger Causality Tests
Date: 12/04/24 Time: 14:16
Sample: 2005 2022
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGEX does not Granger Cause LNTB	320	6.31569	0.0020
LNTB does not Granger Cause LNGEX		4.92911	0.0078

Appendix 9: Heteroskedasticity test

Panel Cross-section Heteroskedasticity LR Test
Null hypothesis: Residuals are homoskedastic
Equation: UNTITLED
Specification: LNTB D(LNGEX)

	Value	df	Probability
Likelihood ratio	13.93636	20	0.8337

LR test summary:

	Value	df
Restricted LogL	-1520.394	339
Unrestricted LogL	-1513.426	339

Unrestricted Test Equation:
Dependent Variable: LNTB
Method: Panel EGLS (Cross-section weights)
Date: 12/04/24 Time: 14:05
Sample: 2006 2022
Periods included: 17
Cross-sections included: 20
Total panel (balanced) observations: 340
Iterate weights to convergence
Convergence achieved after 8 weight iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGEX)	69.99059	7.705651	9.083020	0.0000

Weighted Statistics

R-squared	-301.805932	Mean dependent var	23.58913
Adjusted R-squared	-301.805932	S.D. dependent var	3.089433
S.E. of regression	21.36654	Akaike info criterion	8.908390
Sum squared resid	154763.4	Schwarz criterion	8.919651
Log likelihood	-1513.426	Hannan-Quinn criter.	8.912877
Durbin-Watson stat	0.392935		

Unweighted Statistics

R-squared	-272.969433	Mean dependent var	22.76511
Sum squared resid	154764.1	Durbin-Watson stat	0.447909

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Appendix 10: List of Sub-Saharan Africa countries in the study

Angola	Gambia, The	Mauritania	Senegal	Tanzania
Benin	Kenya	Namibia	Seychelles	Togo
Burkina Faso	Madagascar	Niger	Sierra Leone	Uganda
Cabo Verde	Mali	Rwanda	South Africa	Zambia