Journal of Economics and Behavioral Studies (ISSN: 2220-6140)
Vol. 17, No. 4, pp. 75-87, 2025

Foreign Direct Investment and Exports as A Capacity to Import Vis-À-Vis Trade Balance in Sub-Saharan Africa

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Abstract: We examine the interaction effect of foreign direct investment (FDI) and exports as a capacity to import (ECI) on trade balance in Sub-Saharan Africa (SSA). We utilize balanced annual panel data for 20 SSA countries from 2005 to 2024, obtained from the World Development Indicators. The Generalized Method of Moments (GMM) methodology is used to address endogeneity and unobserved heterogeneity. Empirical findings reveal a positive and statistically significant interaction between FDI and ECI. Specifically, the coefficient of the interaction term (FDI*ECI) is 0.217378, indicating that a simultaneous 10 percent increase in FDI inflows and ECI improves trade balance by approximately 2.2 percent. We recommend that SSA economies adopt integrated strategies that attract export-oriented FDI while promoting export diversification, industrial upgrading, and productive capacity development to achieve sustainable trade balance improvements.

Keywords: *GMM, Foreign direct investment, Exports as a capacity to import, Trade Balance, SSA*

1. Introduction

The external sector remains a critical pillar of macroeconomic stability and sustainable development in Sub-Saharan Africa (SSA). For several decades, the region has been deeply integrated into the global economy primarily as an exporter of primary commodities and an importer of manufactured and capital goods. While this integration has expanded trade volumes, it has also exposed SSA economies to persistent trade imbalances, foreign exchange constraints, and vulnerability to external shocks. Evidence from the World Development Indicators (WDI) shows that most SSA countries have recorded chronic trade deficits continuously from the mid-1970s through 2024, reflecting a structural mismatch between export capacity and import demand (World Bank, 2024).

Foreign direct investment (FDI) has long been promoted as a key mechanism for addressing these external sector challenges. In theory, FDI can enhance productive capacity, facilitate technology transfer, improve export competitiveness, and ultimately strengthen the ability of economies to finance imports without destabilizing the balance of payments (Borensztein et al., 1998; UNCTAD, 2023). However, the SSA experience suggests that rising FDI inflows have not consistently translated into improved trade balances. In many countries, FDI has been concentrated in extractive and enclave sectors with weak domestic linkages, high import dependence, and limited export diversification effects (Asiedu, 2006; UNCTAD, 2022).

At the same time, the structure and sophistication of exports matter critically for external sector sustainability. Exports as a capacity to import (ECI), beyond mere export volumes determines the extent to which exports generate stable foreign exchange earnings capable of financing imports and reducing trade deficits. Economies with more diversified and complex export baskets tend to experience stronger and more resilient trade performance than those dependent on a narrow range of primary commodities (Hausmann et al., 2007; Hidalgo & Hausmann, 2009). In SSA, weak export complexity has constrained the region's capacity to leverage trade as a driver of structural transformation and balance-of-payments stability.

Despite the centrality of these issues, empirical evidence on how FDI interacts with ECI in influencing trade balance outcomes in SSA remains limited. Much of the existing empirical work examines the independent effects of FDI or exports on trade balance, often neglecting the possibility that FDI's impact depends on the nature and sophistication of the export structure. This gap is particularly significant for SSA, where the effectiveness of FDI in improving external balances may hinge on its complementarity with export upgrading and industrial development.

We address this gap by examining the joint role of foreign direct investment and ECI in shaping trade balance performance in SSA. Using annual panel data for 20 SSA countries over the period 2005 to 2024 and employing the dynamic panel Generalized Method of Moments (GMM) technique, we provide robust empirical evidence on whether FDI enhances the export capacity to finance imports. By explicitly focusing on the interaction effect, we offer policy-relevant insights into how SSA economies can realign FDI strategies with export transformation objectives to address persistent trade deficits and strengthen external sector resilience.

2. Literature Review

The relationship between FDI and ECI vis-à-vis trade balance is anchored in classical and modern theories of international trade and investment. Classical trade theories, notably the theory of comparative advantage, posit that countries improve their trade balance by specializing in goods where they have relative efficiency (Ricardo, 1817). However, for many SSA economies, static comparative advantages rooted in primary commodities have constrained export diversification and limited foreign exchange earnings.

The Heckscher–Ohlin model further links trade outcomes to factor endowments, suggesting that capital-scarce SSA economies can benefit from FDI as a vehicle for capital accumulation and technology transfer (Heckscher & Ohlin, 1933). Modern endogenous growth and new trade theories extend this argument by emphasizing scale effects, learning-by-doing, and export sophistication as critical determinants of sustained trade balance improvements (Grossman & Helpman, 1993; Melitz, 2003). From this perspective, FDI enhances trade performance not merely through volume expansion but by upgrading export structures and increasing economic complexity.

Empirical evidence from developed and emerging economies largely supports the export-enhancing role of FDI. A number of studies find that export-oriented FDI improves trade balances by expanding productive capacity, integrating host economies into global value chains, and reducing import dependence (Balasubramanyam et al., 1996; Alfaro et al., 2010). However, the impact is conditional on absorptive capacity, institutional quality, and the nature of FDI inflows.

In developing regions, results are mixed. While FDI has been shown to stimulate exports in East Asia and Latin America, its effect on trade balance is often weakened when FDI is concentrated in enclave sectors or relies heavily on imported intermediate inputs (Aitken et al., 1997). This has led to growing emphasis on interaction effects between FDI and export capability, rather than treating them as independent drivers of external performance.

In SSA, the literature consistently documents persistent trade deficits and limited export diversification despite rising FDI inflows since the early 2000s (UNCTAD, 2023). Several studies argue that resource-seeking and market-seeking FDI have had weak spillovers to export capacity, thereby constraining their impact on trade balance (Asiedu, 2006; Ndikumana & Verick, 2008). Others find that FDI contributes positively to exports only when accompanied by structural transformation and industrial upgrading (World Bank, 2014; Zahonogo, 2016).

Recent studies incorporating export sophistication indicators, such as the Economic Complexity Index, highlight that SSA countries with higher export complexity experience more resilient trade balances and improved import-financing capacity (Hausmann et al., 2014). However, empirical work explicitly examining the interactive role of FDI and ECI on trade balance in SSA remains limited, particularly using dynamic panel techniques that address endogeneity.

Conceptually, our study posits that FDI influences trade balance both directly and indirectly through ECI. FDI enhances production efficiency, technology transfer, and market access, while ECI determines the ability to generate stable foreign exchange earnings. The interaction between FDI and ECI is therefore expected to strengthen the capacity to finance imports and improve the trade balance. The limited SSA-focused empirical evidence on this interaction, especially using dynamic GMM approaches over extended periods, constitutes a critical gap that this study seeks to fill.

3. Data and Method

We adopt a quantitative, explanatory research design based on panel data econometric analysis to examine the relationship between FDI and ECI vis-à-vis trade balance in SSA. A panel framework is appropriate given the cross-country heterogeneity and time-varying macroeconomic dynamics characterizing SSA economies. The design allows for controlling unobserved country-specific effects while capturing both short-run adjustments and long-run structural relationships in external sector performance (Baltagi, 2021; Wooldridge, 2010).

Empirical analysis utilizes balanced annual panel data for 20 SSA countries (Appendix 12), covering the period 2005–2024. The sample selection is guided by data availability and consistency across key variables. All data are sourced from the WDI database of the World Bank, ensuring comparability and reliability across countries and over time (World Bank, 2024).

The dependent variable is the 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 et al., 2018; Salvatore, 2016). The core explanatory variable is the interaction of foreign direct investment inflows times export as a capacity to import (FDI*ECI), which reflects the sophistication and diversification of a country's export structure (Hidalgo & Hausmann, 2009).

All study variables, namely TB, FDI and ECI are first transformed using natural logarithms to enhance econometric reliability and interpretability. Logarithmic transformation compresses large numerical scales and reduces the influence of extreme values, which are common in cross-country macroeconomic data. For instance, while the absolute distance between 10 and 10^{10} is enormous, their logarithmic values differ modestly (from 1 to 10), making relationships more stable and comparable. This transformation also helps linearize potentially nonlinear relationships, mitigate heteroskedasticity, and allows estimated coefficients to be interpreted as elasticities, which is particularly useful for policy analysis in international trade and investment studies (Wooldridge, 2010; Baltagi, 2021).

Given the dynamic nature of trade balance adjustment and the potential endogeneity between FDI, exports, and external sector outcomes, we employ the GMM estimation technique. Specifically, Arellano–Bond and Blundell–Bond system GMM estimators are applied to address simultaneity bias, reverse causality, and unobserved heterogeneity (Arellano & Bond, 1991; Blundell & Bond, 1998).

The baseline dynamic specification includes a lagged dependent variable to capture persistence in trade balance performance, alongside the interaction effect of FDI and ECI. The interaction term (FDI*ECI) tests the hypothesis that the impact of FDI on trade balance is conditional on the level of export sophistication, reflecting the complementarity between foreign investment and productive export structures.

The core equation for trade balance is specified as:

$$TB_{it} = \alpha_0 + \alpha_1 TB_{it-1} + \beta_1 FDI_{it} * ECI_{it} + \varepsilon_{it} \quad \text{.....(1)}$$

Where:

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

TB_{it-1} : Lagged dependent variable capturing trade balance persistence

FDI_{it} : Foreign direct investment in country *i* at time *t*

ECI_{it} : Exports as a capacity to import in country *i* at time *t*

ε_{it} : Error term.

To address endogeneity, lagged values of the endogenous regressor (FDI*ECI) are used as the instrument. The instrument is valid under the assumption that lagged levels of the endogenous variable are uncorrelated with the contemporaneous error term (Arellano & Bover, 1995). Furthermore, the instrument satisfies the orthogonality condition required by GMM, ensuring identification of structural parameters (Bowsher, 2002). Validity is tested using the Hansen J-statistic, which assesses over-identifying restrictions.

Estimation is conducted using a two-step system GMM with robust standard errors to correct for heteroskedasticity and autocorrelation. Instrument validity is assessed using the Hansen test of over-identifying restrictions. Arellano–Bond serial correlation tests are also employed to confirm model consistency. The number of instruments is carefully controlled to avoid instrument proliferation, in line with best econometric practice (Roodman, 2009).

GMM estimator is expressed as:

$\hat{\theta}_{GMM} = \underset{\theta}{\operatorname{argmin}}[\frac{1}{n}\sum_{i=1}^{n} g(X_i,\theta)]' W_n [\frac{1}{n}\sum_{i=1}^{n} g(X_i,\theta)]$ …….…….. (2)

Where:

$g(X_i,\theta) = \frac{1}{n}\sum_{i=1}^{n} Z_i' \varepsilon_i(\theta)$ is the vector of moment conditions,

W_n : A consistent estimate of the weighting matrix,

θ: Vector of structural parameters (Arellano & Bond 1991; Blundell & Bond 1998).

The GMM framework is preferred due to its capacity in handling potential bias from endogenous regressors while accounting for heteroskedasticity and autocorrelation of unknown form (Baltagi, 2021).

4. Results and Discussion

Appendix 1 presents descriptive statistics of the variables, namely foreign direct investment (LNFDI) and exports as a capacity to import (LNECI), expressed in natural logarithms. The mean values of LNFDI (19.74) and LNECI (26.70) suggest moderate but heterogeneous levels of foreign investment inflows and export capacity across SSA countries over the period 2005 to 2024. Relatively wide ranges, LNFDI varying from 14.39 to 24.43 and LNECI from 20.42 to 30.87, reflect substantial cross-country disparities in investment attractiveness and export sophistication within the region.

The standard deviations indicate greater variability in ECI than in FDI inflows, underscoring structural differences in production and export capabilities across SSA economies. Both variables exhibit mild negative skewness, suggesting a concentration of observations above the mean, particularly for ECI. Jarque–Bera statistics reject the null hypotheses of normality, which is common in macro-panel data and justifies the use of robust econometric techniques such as the GMM (Arellano & Bond, 1991; Roodman, 2009).

Stationarity of trade balance (LNTB), foreign direct investment (LNFDI), and exports as a capacity to import (LNECI) is examined using the Augmented Dickey–Fuller (ADF) unit root test (Appendices 2–7). Results indicate that all variables are non-stationary in levels ($p > 0.05$), confirming the presence of unit roots. However, after first differencing, the null hypothesis of a unit root is rejected for each variable ($p < 0.05$), implying that they become stationary. Consequently, they are integrated of order one, I(1), a condition that further justifies the application of dynamic panel estimation GMM, which is well-suited for handling non-stationary variables, endogeneity, and dynamic adjustments in macroeconomic panel data (Dickey & Fuller, 1979; Baltagi, 2021; Arellano & Bond, 1991).

Generalized Method of Moments (GMM) model results (Appendix 8)

$\widehat{\text{LNTB}} = 0.275386 LNTB_{it-1} + 0.217378\text{LNFDI*LNECI}$ ……. (3)

Hence,

$$\hat{\theta}_{GMM} = \begin{bmatrix} 0.275386 \\ 0.217378 \end{bmatrix}$$

Specification of the trade balance model reveals that the lagged dependent variable, $LNTB_{it-1}$, is positive and statistically significant, with a coefficient of 0.275386. This implies that approximately 27.5 percent of past trade balance performance persists into the current period, confirming the presence of trade balance inertia in SSA. The result suggests that improvements or deteriorations in the trade balance tend to be gradual rather than instantaneous, reflecting structural rigidities such as production constraints, import dependence, and adjustment costs in external trade (Pesaran et al., 2001; Arellano & Bond, 1991).

The significance of the lagged trade balance validates the choice of a dynamic panel GMM estimator, as static models would yield biased and inconsistent estimates in the presence of persistence and endogeneity. This finding aligns with earlier studies that document strong path dependence in external sector outcomes among developing economies (Frankel & Rose, 2002; Calderon & Chong, 2001).

The core finding of the study is the positive and statistically significant interaction effect between foreign direct investment and exports as a capacity import (FDI*ECI). The estimated coefficient of 0.217378 implies that a 10 percent simultaneous increase in FDI inflows and ECI, improves the trade balance by approximately 2.2 percent, ceteris paribus. This result highlights the complementarity hypothesis, whereby FDI enhances trade balance only when it is embedded within an export-oriented and structurally diversified economy.

Unlike enclave-type FDI, which often exacerbates import dependence, export-linked FDI strengthens foreign exchange earnings, improves the capacity to finance imports, and reduces chronic trade deficits (Borensztein et al., 1998; Alfaro et al., 2004). This interaction-based evidence represents a unique contribution, as most SSA-focused studies examine the direct effects of FDI or exports independently, rather than their joint impact on trade balance dynamics.

Robustness diagnostics indicate that the residuals deviate from normality, as evidenced by a kurtosis value of 5.71 and a Jarque–Bera probability of 0.00 (Appendix 9), leading to rejection of the null hypothesis of normality. The residual plots further show that some observations fall outside the confidence bands (Appendix 10), suggesting leptokurtic behavior. Such non-normality is common in macro-panel data for developing economies, where structural breaks, external shocks, and cross-country heterogeneity are prevalent (Baltagi, 2021). Crucially, this does not compromise the validity of the GMM estimates, since the estimator does not require normally distributed errors but relies on orthogonality and moment conditions for consistency and efficiency (Arellano & Bond, 1991; Roodman, 2009).

Robustness of the model is further confirmed by the Hansen J-statistic, whose probability value of 0.37 implies a failure to reject the null hypothesis that the instruments are valid. This confirms that the instruments used in the GMM estimation are exogenous and correctly excluded from the estimated equation. Consequently, the model does not suffer from instrument proliferation or over-identification bias, reinforcing the reliability of the estimated coefficients (Roodman, 2009).

Arellano–Bond serial correlation test (Appendix 11) indicates the presence of first-order autocorrelation and absence of second-order autocorrelation in the residuals. Specifically, AR(1) is negative and statistically significant ($m = -3.82$, $p < 0.01$), which is expected in first-differenced dynamic panel models and does not signal model misspecification. In contrast, AR(2) is statistically insignificant ($m = -1.51$, $p = 0.13$), implying no evidence of second-order serial correlation. The absence of AR(2) correlation confirms the validity of the moment conditions and supports the consistency of the GMM estimator employed in the analysis (Arellano & Bond, 1991; Roodman, 2009).

Limitations

Despite its methodological rigor and contribution to understanding the role of FDI and ECI in shaping trade balance outcomes in SSA, our study is subject to several limitations that warrant cautious interpretation of the findings. First, with respect to research design, the study adopts a macro-level panel framework, which while appropriate for capturing cross-country dynamics inevitably abstracts from firm-level, sectoral, and micro-institutional heterogeneity that may influence the effectiveness of FDI and ECI (Helpman et al., 2004; Alfaro et al., 2010). Consequently, the results may not fully capture within-country structural differences, particularly between resource-based and manufacturing-oriented economies.

Secondly, regarding sample and data coverage, the study relies on annual secondary data for 20 SSA countries over the period 2005 to 2024, sourced from the World Development Indicators. Although the panel is balanced, data availability constraints limit the inclusion of all SSA countries and may introduce selection bias toward economies with relatively better statistical reporting systems (Baltagi, 2021). In addition, ECI and aggregate FDI inflows may mask qualitative differences in export sophistication and the sectoral composition of FDI, which are critical for trade balance outcomes (Hausmann et al., 2007).

Lastly, in terms of data analytical procedures, while the GMM estimator is well-suited for addressing endogeneity, simultaneity, and dynamic persistence, it is not without limitations. GMM estimates can be sensitive to instrument proliferation and potential weak instruments, which may bias coefficients if not carefully controlled (Roodman, 2009). Although diagnostic tests, including the J-statistic support instrument validity, the reliance on internal instruments may not fully eliminate all sources of endogeneity, particularly those arising from omitted institutional or geopolitical factors affecting trade balance performance in SSA (Acemoglu et al., 2001).

5. Conclusion and Recommendations

Conclusion

We set out to examine whether foreign direct investment and exports, as a capacity to import jointly, enhance the ability of SSA economies to improve their trade balance. Anchored in dynamic panel econometric analysis and guided by structural trade and development theory, we provided a coherent explanation of how external capital inflows and export sophistication interact to shape external sector outcomes in developing economies. Our findings collectively affirm that trade balance performance in SSA cannot be adequately explained by isolated policy instruments; rather, it emerges from the complementarities between productive FDI and ECI upgrading.

Our study contributes to the broader development economics discourse by demonstrating that the effectiveness of FDI in addressing persistent trade imbalances depends critically on the nature of export structures and productive capabilities within host economies. This insight aligns with structuralist and endogenous growth perspectives, which emphasize the role of industrial upgrading, learning-by-doing, and export diversification in sustaining external balance and long-run growth (Prebisch, 1950; Hausmann et al., 2007; Rodrik, 2018). By integrating ECI into the analysis, the study moves beyond conventional trade balance determinants and highlights the importance of export quality and complexity in shaping Africa's external sustainability.

From a policy standpoint, our study underscores the need for integrated strategies that align FDI attraction with export-oriented industrialization, regional value-chain development, and technological upgrading. Such alignment is particularly critical for SSA economies that continue to experience structural trade deficits, vulnerability to external shocks, and limited domestic productive capacity (UNCTAD, 2023; African Development Bank, 2022). Overall, we reinforce the argument that sustainable improvements in trade balance outcomes in SSA require a shift from volume-based export expansion toward capability-driven, investment-linked export transformation.

Recommendations

Our findings underscore the need for SSA economies to adopt integrated trade–investment policies that deliberately align foreign direct investment inflows with export capacity development. Governments should prioritize attracting export-oriented and productivity-enhancing FDI, particularly into manufacturing, agro-processing, and knowledge-intensive sectors that enhance economic complexity and strengthen the capacity to finance imports. This approach moves beyond volume-based export promotion toward structural transformation of export baskets, which is critical for improving trade balance sustainability (Hausmann et al., 2014; UNCTAD, 2023).

Additionally, macroeconomic and trade policies should emphasize regional value chain participation, especially under the African Continental Free Trade Area (AfCFTA), to enable FDI spillovers across borders and deepen export sophistication. Stable exchange rate management, investment-friendly regulatory frameworks, and targeted fiscal incentives tied to export performance are essential for ensuring that FDI contributes meaningfully to external sector resilience rather than reinforcing import dependence (Rodrik, 2018; IMF, 2022).

SSA governments and development partners should strengthen export capacity-building initiatives, including industrial upgrading programs, skills development, and technology diffusion mechanisms that enhance absorptive capacity for FDI spillovers. Investment promotion agencies should shift from passive FDI attraction

to strategic investment targeting, linking multinational enterprises to domestic suppliers and export markets through local content and supplier development programs (OECD, 2019).

Furthermore, national trade and industrial institutions should invest in export intelligence systems, quality infrastructure, and standards compliance to support firms' integration into global markets. Such programs enhance the effectiveness of FDI–export complementarities, thereby reinforcing countries' ability to finance imports and stabilize trade balances over time (World Bank, 2020).

Future research could extend this analysis by exploring sector-specific dynamics of FDI and ECI, as aggregate measures may conceal important heterogeneities across industries. Further studies could also incorporate firm-level or value-added trade data to better capture micro-level transmission channels through which FDI influences export sophistication and trade balance outcomes.

Methodologically, future work may employ alternative dynamic estimators or non-linear frameworks to assess threshold effects in the FDI–ECI–trade balance nexus, particularly in low-income and fragile SSA economies. Such extensions would enrich the empirical literature on external sector sustainability and inform more nuanced policy design (Aghion et al., 2021).

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APPENDICES

Appendix 1: Descriptive statistics

	LNFDI	LNECI
Mean	19.74268	26.69535
Median	19.73548	27.42601
Maximum	24.42848	30.86505
Minimum	14.39035	20.42241
Std. Dev.	1.427882	2.417976
Skewness	-0.138906	-0.502396
Kurtosis	3.826509	2.482399
Jarque-Bera	12.67161	21.29199
Probability	0.001772	0.000024
Sum	7897.07	10678.14
Sum Sq. Dev.	813.5001	2332.796
Observations	400	400

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

Panel unit root test: Summary
Series: LNTB
Date: 12/23/25 Time: 03:14
Sample: 2005 2024
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*	-3.36325	0.0004	20	360
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.78989	0.2148	20	360
ADF - Fisher Chi-square	50.4277	0.1249	20	360
PP - Fisher Chi-square	58.0121	0.0326	20	380

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

Appendix 3: Unit root test, LNTB (in first difference)

Panel unit root test: Summary
Series: D(LNTB)
Date: 12/23/25 Time: 03:13
Sample: 2005 2024
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*	-8.17086	0.0000	20	340
Null: Unit root (assumes individual unit root process)				

Im, Pesaran and Shin W-stat	-6.35184	0.0000	20	340
ADF - Fisher Chi-square	112.028	0.0000	20	340
PP - Fisher Chi-square	146.681	0.0000	20	360

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

Appendix 4: Unit root test, LNFDI (in Level)

Panel unit root test: Summary
Series: LNFDI
Date: 12/23/25 Time: 03:18
Sample: 2005 2024
Exogenous variables: Individual effects, individual linear trends
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*	0.76983	0.7793	20	360
Breitung t-stat	2.63865	0.9958	20	340
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.09157	0.5365	20	360
ADF - Fisher Chi-square	46.4050	0.2252	20	360
PP - Fisher Chi-square	69.1620	0.0028	20	380

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

Appendix 5: Unit root test, LNFDI (in first difference)

Panel unit root test: Summary
Series: D(LNFDI)
Date: 12/23/25 Time: 03:17
Sample: 2005 2024
Exogenous variables: Individual effects, individual linear trends
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*	-3.09259	0.0010	20	340
Breitung t-stat	-2.63172	0.0042	20	320
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.40848	0.0000	20	340
ADF - Fisher Chi-square	100.621	0.0000	20	340
PP - Fisher Chi-square	286.935	0.0000	20	360

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

Appendix 6: Unit root test, LNECI (in Level)

Panel unit root test: Summary
Series: LNECI
Date: 12/23/25 Time: 03:21
Sample: 2005 2024
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*	-0.75552	0.2250	20	360
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	2.52326	0.9942	20	360
ADF - Fisher Chi-square	30.9319	0.8476	20	360
PP - Fisher Chi-square	97.3108	0.0000	20	380

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

Appendix 7: Unit root test, LNECI (in first difference)

Panel unit root test: Summary
Series: D(LNECI)
Date: 12/23/25 Time: 03:20
Sample: 2005 2024
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*	-6.04949	0.0000	20	340
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.79369	0.0000	20	340
ADF - Fisher Chi-square	119.668	0.0000	20	340
PP - Fisher Chi-square	232.243	0.0000	20	360

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

Appendix 8: Generalized Method of Moments (GMM) model results

Dependent Variable: D(LNTB)
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 12/23/25 Time: 03:39
Sample (adjusted): 2008 2024
Periods included: 17
Cross-sections included: 20
Total panel (balanced) observations: 340
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(D(LNTB),-2) D(LNFDI)*D(LNECI) (-1)

Constant added to instrument list

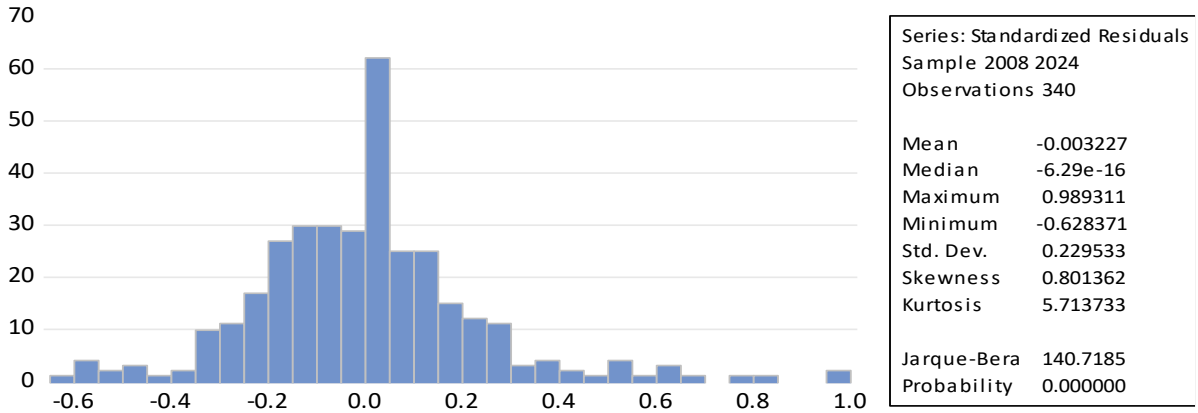
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNTB(-1))	0.275386	0.003985	69.10623	0.0000
D(LNFDI)*D(LNECI)	0.217378	0.003123	69.60932	0.0000

Effects Specification

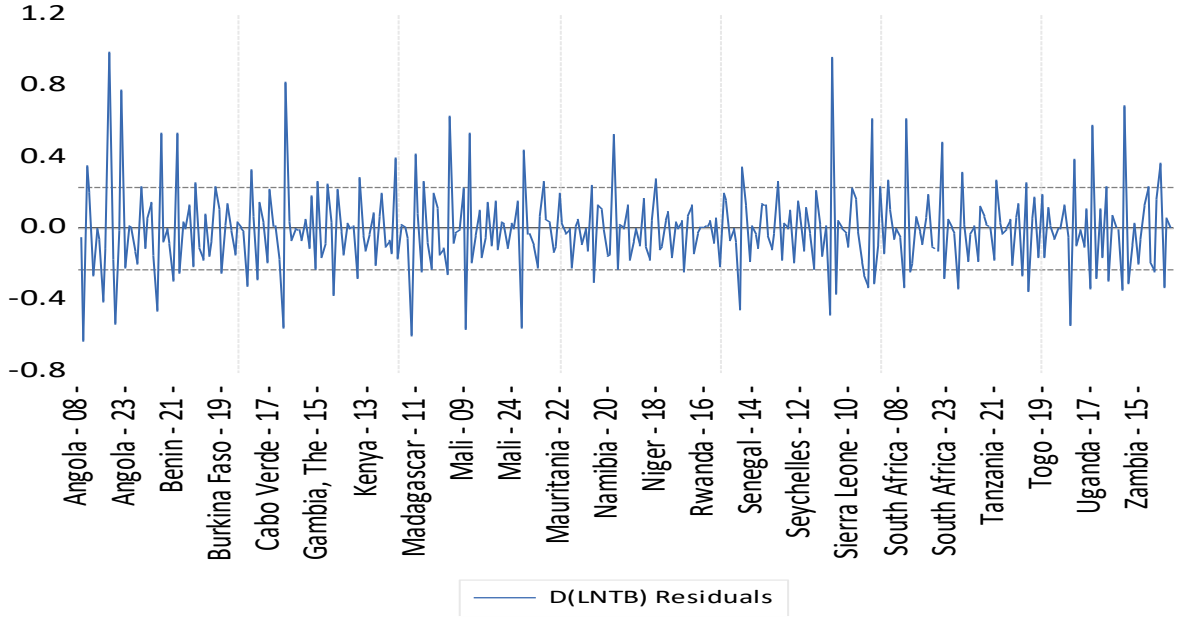
Cross-section fixed (first differences)

Mean dependent var	-0.003348	S.D. dependent var	0.206568
S.E. of regression	0.229895	Sum squared resid	17.86383
J-statistic	19.33955	Instrument rank	20
Prob(J-statistic)	0.371200		

Appendix 9: Normality test



Appendix 10: Graph of residuals



Appendix 11: Serial Correlation Test

Arellano-Bond Serial Correlation Test

Equation: Untitled

Date: 12/23/25 Time: 06:55

Sample: 2005 2024

Included observations: 340

Test order	m-Statistic	rho	SE(rho)	Prob.
AR(1)	-3.819584	-7.670544	2.008215	0.0001
AR(2)	-1.508448	-2.603544	1.725976	0.1314

Appendix 12: 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