


Autoregressive Distributed Lag (ARDL) Bounds Cointegration and Short-Run Analysis of the Impact of Capital Inflows and Institutional Quality on Labour Productivity

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ARTICLE INFO	Abstract
<p>Keywords: <i>ARDL, Labour Productivity, Capital Inflows, Institutional Quality, Nigeria.</i></p> <p>©2026 Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International</p> 	<p><i>This study uses the Solow-Swan model to link labour productivity with capital, labour, and technology. It applies the ARDL approach to examine how international capital inflows affect productivity in Nigeria, including FDI, FPI, debt, aid, and remittances, with control variables. Cointegration and ECM capture long- and short-run dynamics. Institutional quality is included as a moderator. Robustness is ensured with FMOLS and diagnostic tests using 1992–2024 time-series data from multiple sources. Short-run results show that FDI (-0.0012) was insignificant, while FPI (0.0000), ODA (0.1632), external debt (0.3852), and institutional quality (0.5131) significantly influenced labour productivity. The error correction term (-1.1137) confirms rapid adjustment to long-run equilibrium. The findings suggest that while international capital inflows are important drivers of productivity, their effectiveness depends largely on the quality of institutions. The study recommends strengthening governance structures, improving regulatory efficiency, and ensuring effective allocation of external resources to maximize productivity gains and support sustainable economic growth in Nigeria.</i></p>

1. Introduction

The analysis of the impact of capital inflows and institutional quality on labour productivity has become increasingly important, particularly in developing economies where productivity growth remains relatively low despite rising external financial flows. Labour productivity reflects the efficiency of labour in generating output, and it is often influenced by access to capital, technology, and the institutional environment. However, empirical evidence shows that increased capital inflows do not always translate into improved productivity, thereby creating a policy-relevant problem. Many developing countries, including Nigeria, experience substantial capital inflows such as foreign direct investment (FDI), portfolio investment, and remittances, yet labour productivity remains stagnant. This suggests that the effectiveness of such inflows depends largely on institutional quality. Weak governance, corruption, and poor regulatory frameworks can hinder the productive use of capital, thereby limiting its impact on labour productivity (Nxumalo & Makoni, 2021).

To examine these dynamics, the Autoregressive Distributed Lag (ARDL) bounds testing approach is widely employed. The ARDL model is particularly suitable because it accommodates variables integrated at different orders, $I(0)$ and $I(1)$, and provides reliable estimates for small sample sizes. It also enables simultaneous estimation of both long-run equilibrium relationships and short-run dynamics. The ARDL bounds testing technique is used to determine whether a long-run relationship exists among labour productivity, capital inflows, and institutional quality (Chala, 2026). The procedure involves estimating an unrestricted error correction model and conducting an F-test to compare against critical bounds. If the F-statistic exceeds the upper bound, cointegration is confirmed.

Recent empirical studies using ARDL show strong evidence of long-run relationships between capital inflows and macroeconomic performance indicators. For instance, studies in Nigeria

confirm that foreign capital inflows and institutional quality are cointegrated, implying that these variables move together in the long run (Igbinedion & Obayagbona, 2022). Similarly, Ofiero et al. (2022) found a stable long-run relationship between foreign inflows and economic development using ARDL techniques. In the context of labour productivity, this implies that sustained inflows of capital when supported by strong institutions which can enhance productivity through technology transfer, skill acquisition, and improved capital-labour ratios. However, institutional quality acts as a conditioning variable. Evidence suggests that without strong institutions, the long-run benefits of capital inflows may be weak or even negative due to inefficiencies and misallocation of resources (Wada, 2024).

Once cointegration is established, the ARDL framework incorporates an Error Correction Model (ECM) to analyze short-run dynamics. The ECM captures how quickly deviations from long-run equilibrium are corrected. The error correction term (ECT) is expected to be negative and statistically significant, indicating convergence. Empirical findings reveal that capital inflows often exhibit mixed short-run effects. For example, foreign portfolio investment and external debt may significantly influence economic outcomes only in the short run, while FDI and institutional quality tend to exert more stable long-run effects (Jude & Levieuge, 2017). This suggests that short-term fluctuations in capital inflows can lead to volatility in labour productivity, especially in economies with weak institutional frameworks.

Short-term fluctuations in capital inflows can create instability in labour productivity, particularly where institutional and structural support systems are weak. This mirrors findings in business education where resource availability alone does not guarantee improved performance without supportive frameworks (Onyiorah, 2021; Onyiorah, 2021b). The effective utilization of resources, including digital tools and innovative strategies, is crucial for sustaining outcomes (Oguejiofor & Onyiorah, 2021; Onyiorah, 2022). Furthermore, human capital development, entrepreneurial skills, and professional training enhance long-term productivity (Oguejiofor et al., 2022; Onyiorah, 2023a). However, factors such as family background and learning conditions can influence outcomes (Oguejiofor & Onyiorah, 2023; Onyiorah, 2023b). Hence, sustained productivity depends on supportive institutional environments and skill development (Okoro et al., 2025).

Moreover, ARDL-based studies show that capital inflows can have immediate positive impacts by increasing liquidity and investment levels, but such gains may not persist without institutional support. For instance, foreign inflows may initially boost output and employment, yet their sustainability depends on governance quality and policy consistency (Ofiero et al., 2022). The combined ARDL long-run and short-run analyses highlight that capital inflows alone are insufficient to drive productivity growth. Institutional quality such as rule of law, regulatory effectiveness, and control of corruption which plays a critical mediating role. In the long run, strong institutions enhance the positive impact of capital inflows, while in the short run, they help stabilize fluctuations and improve adjustment speed.

While existing studies show that capital inflows can stimulate economic performance, evidence on their consistent impact on labour productivity remains mixed, especially in developing economies (Adeleye et al., 2020; Asongu & Odhiambo, 2021). Moreover, limited attention has been given to the joint role of institutional quality in moderating these effects. This study fills this gap by integrating long-run and short-run dynamics, providing deeper insight into how institutional weaknesses may constrain productivity gains from external capital.

2. Methodology

The methodology of this study is grounded in the Solow-Swan neoclassical growth model, which provides a dynamic framework linking output per labour to capital accumulation, labour, and technological progress. The model assumes that output is produced through the interaction of capital (K), labour (L), and knowledge or technology (A), with diminishing returns to individual factors.

While increases in capital or labour can enhance output in the short run, long-term growth is primarily driven by technological advancement. This theoretical foundation supports the study's focus on labour productivity and the role of international capital inflows. Building on this theory, the study adopts the Autoregressive Distributed Lag (ARDL) modelling approach, particularly drawing from Hailat and Baniata (2018), due to its simplicity, flexibility, and suitability for analyzing dynamic relationships. The ARDL framework allows for different lag structures across variables and captures both short-run and long-run effects within a single-equation model. It is especially appropriate for time-series data that may be integrated of order zero or one.

The empirical model is specified to examine the impact of international capital inflows on labour productivity in Nigeria. Labour productivity, measured as GDP per person employed, is modeled as a function of foreign direct investment (FDI), foreign portfolio investment (FPI), external debt (EDS), official development assistance (ODA), and personal remittances (PRER). To improve model robustness, control variables such as gross fixed capital formation (GFCF), real GDP (RGDP), and secondary school enrolment (SERR) are included to account for physical capital formation, economic size, and human capital development, respectively. The ARDL model is estimated in both its levels form and its error correction representation. The bounds testing approach is used to determine whether a long-run equilibrium relationship exists among the variables. If cointegration is confirmed, an error correction model (ECM) is derived to capture the speed of adjustment from short-run disequilibrium to long-run equilibrium. The ECM integrates both short-run dynamics and long-run relationships without losing essential information.

A composite institutional quality index (INSQIDX), constructed using principal component analysis from governance indicators, is interacted with components of capital inflows (e.g., $FDI \cdot INSQIDX$). This allows the study to examine how governance conditions influence the effectiveness of foreign capital in enhancing labour productivity. The choice of ARDL is justified by several advantages. It accommodates mixed integration orders, performs well with small sample sizes, and allows optimal lag selection using information criteria. Additionally, it distinguishes between short-run fluctuations and long-run equilibrium relationships. To ensure robustness, the Fully Modified Ordinary Least Squares (FMOLS) estimator is also employed to validate long-run results and correct for potential endogeneity and serial correlation.

The study follows a rigorous estimation procedure involving both pre- and post-estimation tests. Pre-estimation diagnostics include descriptive statistics, unit root tests (ADF and Phillips-Perron), multicollinearity checks, and cointegration tests. Post-estimation tests assess model reliability through autocorrelation (Breusch-Godfrey), heteroscedasticity (Breusch-Pagan-Godfrey), and stability tests (CUSUM and CUSUMSQ). Hypotheses are tested using t-statistics at a 5% significance level. The study uses annual time-series data from 1992 to 2024, sourced from the World Bank, World Governance Indicators, and the Central Bank of Nigeria

4. Results

Table 1: Bounds Test Result for LP Estimation

Test Statistic	Value	K	Significance	I(0) Bound	I(1) Bound
F-Statistic	17.78298	8	10%	1.85	2.85
			5%	2.11	3.15
			2.5%	2.33	3.42
			1%	2.62	3.77

From Table 1, the value of the F-statistic in the first model shows that the joint significance of the lagged level variables is 17.783, which is greater than the upper bound I (1) at a 5% level of significance. Therefore, we reject the null hypothesis and conclude that a long-run relationship exists between the dependent variable and the independent variables. The second model in Table 2 has its

F-statistic at 7.423, which is greater than the joint significance of the lagged level variables at the upper bound I (1) at a 5% level of significance. Hence, this study concludes that a long-run relationship exists between the dependent variable and the independent variables.

Table 2: Bounds Test Result with Institutional Quality Index

Test Statistic	Value	K	Significance	I(0) Bound	I(1) Bound
F-Statistic	7.423331	9	10%	1.80	2.80
			5%	2.04	2.08
			2.5%	2.24	3.35
			1%	2.50	3.68

Source: Computed using E-views 10

4.1 Short Run Estimation and Interpretation for the model with the ARDL Model

Table 3: The Short Run Estimated Coefficient for the Model

Variables	Coef.	Std. Error	Prob.
	ARDL		
D(LOGLP(-1))	0.9982*	0.0322	0.0001
D(FDI)	-0.0012	0.001	0.3152
D(FPI)	0.0000*	0.0000	0.0007
D(LOGODA)	0.1632*	0.0086	0.0003
D(LOGEDS)	0.3852*	0.0220	0.0004
D(INSQ_IDX)	0.5131**	0.1115	0.0193
D(INSQ_FDI)	-0.0123*	0.0012	0.0020
D(INSQ_FPI)	0.0000*	0.0000	0.0008
D(INSQ_LOGODA)	0.0723*	0.0044	0.0005
D(INSQ_LOGEDS)	0.0794*	0.0059	0.0009
CointEq(-1)*	-1.1137*	0.0643	0.0004

Source: Computed using E-views 10

Note: * denotes significance at 1%, ** denotes significance at 5%

In the short-run dynamics in Table 3, the coefficient on the first difference of FDI net inflows is negative 0.0012 with a probability value greater than 0.05, indicating statistical insignificance at conventional levels. This suggests that year-to-year fluctuations in FDI net inflows have no detectable immediate impact on labour productivity. In other words, short-term increases or decreases in inflows do not translate into contemporaneous changes in output per worker, conditional on the error correction adjustment. Short-run dynamics reveal that the coefficient on foreign portfolio investment net inflows is 0.0000 but statistically significant at the 1 percent level. Although the numerical value is effectively zero, the positive sign indicates that contemporary increases in portfolio flows are positively correlated with short-run upticks in labour productivity.

The short-run estimator in Table 3 shows that the coefficient of net inflows of official development assistance is 0.1632, significant at the 1 percent level with a probability value less than 0.01. This suggests that if ODA disbursements increase by 1 percent within a given period, labour productivity responds with a 0.1632-point rise in the same period. In the short run, the outcome of the estimation reveals that the coefficient of external debt flow is 0.3852 and significant at the 1 percent level with a probability value less than 0.01. This large positive coefficient indicates that, when external debt flow rises by 1 percent in a given period, labour productivity temporarily increases by nearly 0.3852 points. Such a strong concurrent effect may arise because new external loans are often disbursed quickly for high-profile infrastructure or capital projects, yielding immediate but perhaps short-lived improvements in production capacity or operational efficiency.

The estimated result in Table 3 shows the short-run coefficient of the institutional quality index at 0.5131, statistically significant at the 5% level with a probability value less than 0.05. This indicates that an incremental improvement of one unit in the institutional quality index during the period under review is associated with a 51 percent immediate rise in labour productivity in Nigeria.

Moderating the effect of foreign direct investment net inflows using the institutional quality index on labour productivity disclosed that in the short run, the coefficient was shown to have a negative impact of 1.23%, which is significant at the 1 percent level with a probability value less than 0.01. This indicates that an increase in the interaction between changes in institutional quality and FDI net inflows (i.e., a simultaneous rise in both) is associated with a 1.23 percent short-run decline in labour productivity. Essentially, if both institutional reforms and FDI net inflows accelerate in the same period, LP may experience a small, immediate contraction. In the short run, the moderating effect of foreign portfolio investment net inflows using the institutional quality index on labour productivity results indicates a coefficient of 0.0000, significant at the 1 percent level with a probability value less than 0.01. Although numerically negligible, this positive coefficient suggests that when both institutional quality and portfolio inflows rise in the same period, there is a minute positive effect on labour productivity.

The short-run coefficient for the moderating effect of external debt flow using the institutional quality index on labour productivity revealed a negative value of 0.0794, which is significant at the 1 percent level with a probability value of less than 0.01. This indicates that when institutional quality and external debt flows both increase in a given period, labour productivity experiences a short-run decline of approximately 0.0794 points. The short-run coefficient for the moderating effect of net inflows of official development assistance using the institutional quality index on labour productivity revealed a value of 0.0723, significant at the 1 percent level with a probability value of less than 0.01. This indicates that concurrent increases in both institutional quality and ODA net inflows yield an immediate 0.0723-point rise in labour productivity.

The error-correction term [CointEq(-1)] coefficient indicated a value of negative 1.1137, with a probability value less than 0.01. The coefficient's magnitude exceeding unity in absolute value suggests an over-adjustment mechanism whenever the system deviates from its long-run equilibrium (e.g., due to shocks to FDI, ODA, or institutional quality), more than 100 percent of that deviation is corrected within the next period. Economically, an ECM coefficient of -1.1137 implies that if labour productivity is, say, 1 percent below its long-run path given current levels of the regressors, it will overshoot by 0.1137 percent above the equilibrium in the next period before adjusting back, potentially creating dampened oscillations. This rapid adjustment underscores that short-run shocks (whether from external borrowing, foreign investment, or governance changes) have only transitory impacts on LP, as the economy swiftly realigns with its long-run productivity trajectory. Short-run dynamics exhibit strong immediate responses to changes in external debt flow and net inflows of ODA (both positive), while FDI net inflows show no short-run effect, and the FPI net inflows effect is effectively nil. The significant, large-magnitude error-correction term indicates swift convergence to a long-run equilibrium whenever shocks occur.

5. Discussion

The ARDL bounds test results confirm a long-run relationship between labour productivity and capital inflows, as the F-statistics exceed the upper critical bounds. This finding agrees with Abubakar (2025), who also found evidence of cointegration between capital inflows, institutional quality, and economic growth in Nigeria, indicating that external capital variables have enduring macroeconomic effects. In contrast, some cross-country studies suggest that such long-run relationships may vary depending on structural conditions, highlighting country-specific dynamics. In the short run, the insignificance of FDI aligns with findings by Saha et al. (2022), who reported that FDI may not exert immediate economic effects due to absorptive capacity and institutional

constraints. Similarly, Gokceli (2023) found that institutional quality does not significantly influence FDI effects in the short run, reinforcing the weak immediate impact observed. In contrast, other studies emphasize the long-term benefits of FDI through technology transfer rather than short-run productivity gains.

The positive but negligible impact of FPI is consistent with findings that portfolio flows often have limited real-sector effects. In a related study, research on Nigeria's capital inflows showed that FPI tends to influence macroeconomic variables mainly in the short term without strong structural impact. In contrast, studies in more developed financial systems report stronger transmission channels from portfolio investment to productivity. The positive and significant effect of ODA agrees with Juselius et al. (2022), who found that aid can enhance productivity when effectively allocated to infrastructure and human capital. Similarly, the positive effect of external debt is in line with Legesse et al. (2021), who observed that debt can support growth through investment financing. However, in contrast, other literature warns that excessive debt may undermine long-term sustainability.

Institutional quality shows a significant positive impact on labour productivity, which agrees with Uddin et al. (2023), who found that strong institutions enhance economic development and productivity outcomes. However, the negative interaction between institutional quality and FDI contrasts with Saha et al. (2022), where institutional improvements were expected to enhance FDI effectiveness. Conversely, the positive interaction between institutional quality and ODA aligns with studies emphasizing that governance improves aid effectiveness. The significant and large error correction term indicating rapid adjustment supports ARDL-based findings that economies quickly revert to long-run equilibrium aftershocks. This is consistent with recent ARDL applications showing strong convergence dynamics in developing economies.

6. Conclusion

The study examined the impact of international capital inflows and institutional quality on labour productivity in Nigeria using the Autoregressive Distributed Lag (ARDL) bounds testing approach. Grounded in the Solow-Swan neoclassical growth framework, the analysis incorporated key components of capital inflows of foreign direct investment (FDI), foreign portfolio investment (FPI), external debt, official development assistance (ODA), and remittances alongside institutional quality and relevant control variables. The findings from the ARDL bounds test confirmed the existence of a stable long-run relationship between labour productivity and the explanatory variables in both model specifications. This indicates that capital inflows and institutional quality jointly influence productivity over time. In the short run, however, the effects vary across components. External debt and ODA were found to have significant positive effects on labour productivity, suggesting that these inflows may support immediate improvements in infrastructure and productive capacity. In contrast, FDI showed no significant short-run impact, while FPI exhibited only a marginal effect.

Institutional quality emerged as a crucial factor in shaping productivity outcomes. Improvements in governance significantly enhanced labour productivity directly. However, the interaction effects revealed mixed results: while institutional quality strengthened the positive impact of ODA and, to a lesser extent, FPI, it dampened the short-run effects of FDI and external debt. These findings suggest that the effectiveness of capital inflows depends not only on their volume but also on the quality of institutions that guide their allocation and utilization. Furthermore, the error correction mechanism demonstrated a rapid adjustment toward long-run equilibrium following short-term shocks, indicating that deviations from equilibrium are quickly corrected. This underscores the resilience of the Nigerian economy in realigning productivity dynamics after fluctuations in capital inflows or institutional changes.

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