



EFFECT OF INTERNATIONAL REMITTANCES ON HOUSEHOLD INCOME AND INVESTMENT IN NIGERIA: THE MODERATING ROLE OF FINANCIAL SECTOR DEVELOPMENT

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ABSTRACT: *This study examined the moderating role of financial sector development in shaping the heterogeneous impact of international remittances on household income in Nigeria. The study adopted the newly developed quantile nonlinear autoregressive distributed lag (QNARDL) model and the findings reveal substantial heterogeneity in the manner remittances influence household income across diverse quantiles. First, it demonstrates that in the short run, positive changes in remittance inflows significantly increase household income, particularly at the middle and upper quantiles, with the effect increasing as one moves up the income distribution. This underscores the heterogeneous nature of remittances' impact, suggesting that higher-income households benefit more proportionally from increased remittance inflows. Second, financial sector development has a consistently positive and significant effect on household income across all quantiles in both the short and long run. Third and more importantly, the interaction results confirm that a deeper and more efficient financial sector amplifies the positive effect of remittances on household income, especially in the upper quantiles, by enhancing access to credit, encouraging savings, and enabling productive investments. The study recommended the introduction of government-backed instruments, such as diaspora bonds, cooperative savings schemes, or matched-fund programs, that channel remittances into small business financing, housing, and infrastructure projects. Also, the government should offer tax incentives or reduced transaction fees for remittance recipients who deposit and invest funds in formal financial institutions.*

KEYWORDS: Financial sector development, International remittances, Household income, Distributional impact, Quantile nonlinear ARDL.

JEL Classification: C22, C52, D14, E22, E44, F24



INTRODUCTION

International remittances have emerged as a crucial source of external financing for numerous developing economies, frequently exceeding the scale of foreign direct investment and official development aid (World Bank, 2024). Remittances can offer recipient households a consistent income source that stabilises consumption, alleviates poverty, and improves investments in human capital (Adams & Cuecuecha, 2013; Combes & Ebeke, 2021). At the macroeconomic level, they augment foreign exchange reserves and can enhance economic resilience during crises. Empirical research indicates that the impact of remittances on household income is not consistent nor automatic; it is influenced by structural and institutional elements within the recipient economy (Giuliano & Ruiz-Arranz, 2009). Among these elements, the expansion of the financial sector emerges as a crucial modulator of the remittances–income relationship. An advanced financial system improves resource allocation efficiency by mobilising funds, easing credit availability, and enabling risk management (Levine, 1997). An effective and inclusive financial sector can convert remittance inflows from simple consumer support into productive investments, thereby fostering entrepreneurship, asset accumulation, and sustained income development (Aggarwal et al., 2011). In contrast, in underdeveloped financial systems, remittances are often directed towards immediate spending or low-yield applications, so constraining their long-term income-generating capacity.

Notwithstanding this theoretical agreement, empirical research regarding the moderating influence of financial development on remittances–household income nexus is limited, especially in low- and middle-income nations where remittances constitute a primary income source. Current research predominantly emphasises the macroeconomic impacts of remittances on growth, poverty alleviation, or inequality, frequently overlooking the disparities within the income distribution and the institutional frameworks that influence these effects (Anyanwu & Erhijakpor, 2010; Ajefu & Ogebe, 2020). Furthermore, the majority of previous studies utilise mean-based estimating methods, neglecting possible nonlinearities and asymmetries in the interaction between remittances and financial development in affecting household well-being (Giuliano & Ruiz-Arranz, 2009).

In Nigeria—a prominent remittance recipient in sub-Saharan Africa—these challenges are particularly pertinent. The nation receives billions of dollars each year from its diaspora; nonetheless, enduring income disparity and poverty indicate that the full developmental potential of remittances is not being actualised (World Bank, 2023). Nigeria's financial industry, while growing, continues to display structural deficiencies, such as restricted rural access, elevated borrowing costs, and disproportionate credit distribution. This poses a crucial inquiry: Does the profundity and efficacy of Nigeria's banking sector enhance or limit the potential of remittances to elevate household incomes among various income brackets? Addressing this inquiry is both intellectually pertinent and relevant to policy. Comprehending the banking sector's moderating function might guide specific reforms that optimise developmental benefits from remittance inflows. This can assist policymakers in formulating financial inclusion initiatives, remittance-associated savings and investment products, and macroeconomic policies that synchronise external capital flows with national development objectives.

This research adds to the existing body of knowledge by using a quantile nonlinear autoregressive distributed lag (QNARDL) method, which enables the identification of short-



and long-term heterogeneous and asymmetric impacts across the distribution of household income. The analysis provides a detailed understanding of the circumstances in which remittances can promote inclusive and long-term income growth by combining the examination of remittances, household income, and financial sector development.

The organisation of the study is outlined below, excluding the introduction: The second section presents a literature review, the third discusses the methodology, the fourth examines the conclusions and empirical data, and the fifth concludes with recommendations for future policy.

LITERATURE REVIEW

The relationship between international remittances and household income is mediated by several well-established channels. First, consumption-smoothing and poverty-alleviation channels: remittances provide households with a supplementary and often stable source of funds that smooths consumption in the face of idiosyncratic or aggregate shocks, directly raising disposable household income and welfare (Adams & Cuecuecha, 2013; Combes & Ebeke, 2021). Second, the investment channel: when remittance recipients use inflows to fund small business start-ups, education, or productive assets, remittances can raise long-run household income via higher returns to labor and capital. Third, financial intermediation and credit-constraint channels: the extent to which remittances translate into investment (rather than only consumption) depends crucially on the depth, access, and efficiency of the financial sector. A developed financial sector lowers transaction costs, offers saving and borrowing instruments, and improves matching between savers and entrepreneurs; thus, it increases the propensity of remittances to be channelled into productive uses (Levine, 1997; Aggarwal et al., 2011). Fourth, risk management and portfolio channels: effective formal financial services (bank deposits, insurance, credit) allow households to smooth risk and undertake longer-horizon investments that raise income. Finally, there is potential heterogeneity across the income distribution: wealthier households may be better positioned to leverage remittances into investment when financial services and collateral markets are accessible, whereas poorer households may use remittances mainly for immediate consumption unless financial inclusion is improved.

Putting these together generates a clear theoretical prediction for the moderating role of financial sector development: financial development amplifies the positive effect of remittances on household income, particularly by enabling conversion of remittance inflows into savings, credit-financed investment, and human-capital accumulation (Giuliano & Ruiz-Arranz, 2009; Levine, 1997). The magnitude and distribution of this amplification may vary across the household income distribution (i.e., be larger in middle and upper quantiles) unless targeted financial inclusion policies reduce such heterogeneity.



Empirical Literature

Remittances and Household Welfare

Several cross-country and multi-country micro-studies find that remittances raise household consumption, reduce poverty, and increase investment in human capital (e.g., schooling, health), though effects vary by country and measurement. Adams and Cuecuecha (2013) document positive effects on investment and poverty reduction in Ghana, while Combes and Ebeke (2021) examine consumption instability and highlight the stabilising role of remittances for household consumption in developing countries. These studies support the basic income-boosting role of remittances but also emphasise heterogeneity in outcomes across contexts and households. Few studies in Nigeria find that remittances matter for household outcomes and investment but that effects are uneven—often benefiting certain groups more (Anyanwu & Erhijakpor, 2010; Ajefu & Ogebe, 2020). Anyanwu and Erhijakpor (2010) document remittances' role in poverty reduction in Africa, while Ajefu and Ogebe (2020) discuss remittances and physical investment purchases in Nigeria. These studies motivate a closer look at within-country heterogeneity (e.g., by income quantile, region, or household type) and at institutional mediators like financial sector depth and access. These studies adopted the traditional mean-based estimators (OLS or standard ARDL), which can mask heterogeneous effects across the distribution of household incomes and hence, fail to capture asymmetric responses to positive vs. negative remittance shocks.

Financial Development as Mediator/Moderator

There is theoretical and empirical evidence that financial development conditions remittance effects. Giuliano and Ruiz-Arranz (2009) provide a foundational cross-country analysis showing that remittances have larger growth and investment effects in countries with more developed financial systems. Aggarwal, Demirgüç-Kunt, and Pería (2011) examine whether remittances promote financial development and show bidirectional relationships: remittances can encourage financial deepening (through increased deposits and demand for services), while financial development affects how remittances are allocated. These studies motivate treating financial development not only as a control but as a moderator in empirical models. Interaction/interaction-term evidence. Empirical papers that include interaction terms between remittances and financial sector indicators generally find that better financial infrastructure increases the productive use of remittances (higher investment, higher savings rates) and their developmental multiplier (Giuliano & Ruiz-Arranz, 2009; Aggarwal et al., 2011). This supports estimating how financial sector development shapes the remittances-income nexus in both the short and long run, across diverse quantiles, capturing how marginal changes in financial development alter the remittance-income elasticity.

To the best of our knowledge, few studies combine nonlinearity/asymmetry and quantile dynamics with explicit moderation by financial development. The QNARDL analysis addresses whether financial sector improvements amplify remittances' income effects differently for poorer versus richer households and whether those moderating effects are short-run, long-run, or both.



ESTIMATION FRAMEWORK

Data Description

This analysis employs quarterly data from 1996 to 2022 to exemplify the distributional impacts of foreign remittances on household income and investment, alongside the moderating effect of financial sector development on the distributional relationship between these variables. The study's data was obtained from the World Bank data repository and the Central Bank of Nigeria Statistical Bulletin in alignment with the study's objectives. Table 1 offers a comprehensive elucidation of the series.

Table 1: Data Descriptions

Variables	Representation	Unit of dimension	Source
International Remittances	IRM	Personal remittances Received which consist of personal transfers and compensation of employees (% of GDP)	WDI
Household Income	HIN	Gross Domestic Product per capita at 2010 constant prices (Local currency)	WDI
Financial Sector Efficiency	FSE	Credit to private sector (% GDP)	CBN
Exchange rate	EXE	Nigerian exchange rate vis-à-vis US dollar	CBN
Interest rate	RIR	Prime lending rate (percentage)	CBN
Institutional Quality	INQ	Institutional Quality (Index)	WDI
Trade openness	OPN	The ratio of the sum of import and exports to GDP	CBN

Note: CBN represents the Central Bank of Nigeria, and WDI epitomises world development indicators at the world bank repository.

Method of Data Analysis

This study analysed the distributional impact of international remittances on household income and how this connection is modulated by financial sector development in Nigeria, utilising the cutting-edge Quantile Nonlinear Autoregressive Distributed Lag (QNARDL) model introduced by Cho et al. (2020; 2021). The QNARDL, formulated by Cho et al. (2020), represents an enhancement of the QARDL created by Cho et al. (2019). The selection of this estimation procedure is based on its numerous advantages compared to QARDL and nonlinear ARDL, as it allows for the estimation of both sign-based and magnitude-based asymmetric distributional quantile effects of regressors on the response (Cho et al., 2020; 2021). This has led to its application in contemporary scientific research (Odionye et al., 2024a). It is also utilised within fractionally integrated series. This approach indicates both the magnitude and direction of severe positive and negative changes in remittances and its modulation influence on domestic investment and income in the country. This understanding is essential, as not all fluctuations in remittances (whether negative or positive) will impact income and investment; however, specific alterations in remittances will affect domestic consumption and investment and, thus, income. However, the QNARDL estimate process



fails when used within higher-order stationary series, which is its principal restriction (Cho et al., 2015; Cho et al., 2020; 2021; Odionye & Chukwu, 2023; Odionye et al., 2024c; Odo et al., 2025).

Model Specifications

In line with the theoretical views and relevant past studies (Abubakar, 2019; Nwankwo et al., 2017), the study considers the functional forms:

$$LHIN_t = b_0 + b_1LIRM_t + b_2LFSE_t + b_3LEXE_t + b_4LRIR_t + b_5LOPN_t + b_6LINQ_t + \varepsilon_{it}\varepsilon_{it} \quad (1)$$

$$LHIN_t = b_0 + b_1[LIRM_t * LFSE_t] + b_3LEXE_t + b_4LRIR_t + b_5LOPN_t + b_6LINQ_t + \varepsilon_{it}\varepsilon_{it} \quad (2)$$

Eqn. 1 expresses household income (HIN) as a function of international remittances (IRM), financial sector efficiency (FSE), exchange rate (EXE), interest rate (RIR), openness (OPN), and institutional quality (INQ), respectively. On the other hand, eqn. 2 expresses HIN as a function of the interaction between financial sector development and international remittances, as well as other covariates. In eqns. 1 and 2, L represents the natural log of the series. Furthermore, the subscript 't' denotes the time period, while 'ε' indicates the stochastic error term. Given their shared ancestry, the institutional quality indices might be highly related. In order to overcome this challenge, the study utilised principal component analysis (PCA) to develop an index INQ that encompasses all of the INQ manifestations. The selection of the control variables was influenced by previous research and economic theory. Cho et al. (2015) specify a model that follows Pesaran and Shin (1998); therefore, computing the QARDL in accordance with their guidelines is the first step.

$$Z_t[X(\tau)] = \psi_0(\tau) + \psi(\tau)Z_t + \sum_{j=1}^p \delta_j(\tau)Z_{t-j} + \sum_{j=0}^q \varphi_j(\tau)X_{t-j} + \mu_t$$

where $\psi_i(\tau) = \sum_{i=0}^p \psi_i$ and $\varphi(\tau) = - \sum_{i=1}^q \varphi_i(\tau)$ (3)

The quantile connectivity representing the long-run operational function is expressed in Eqn. 3

$$Z_t = \alpha(\tau) + \gamma(\tau)X_t + \mu_t$$

where $\alpha = \psi \left(1 - \sum_{i=1}^p \delta_i(\tau) \right)^{-1}$ and $\gamma = \psi_1 \left(1 - \sum_{i=1}^q \varphi_i(\tau) \right)^{-1}$;

μ_t is a stationary process expressed as $(\Delta X_t, \mu_t(\tau), \Delta X_{t-1}, \mu_{t-1}(\tau), \dots)$ (4)

Following Cho et al., (2020), the QNARDL generalized function is specified in Eqn. 5

$$\Delta Z_t[X(\tau)] = \psi(\tau) + \psi(\tau)Z_{t-1} + \sum_{i=1}^p \delta_i(\tau)\Delta Z_{t-i} + \sum_{i=0}^q (\varphi_i^{pos}(\tau)\Delta X_{t-i}^{pos} + \varphi_i^{neg}(\tau)\Delta X_{t-i}^{neg}) + \theta(\tau)ect + \alpha_1^{pos}(\tau)X_t^{pos} + \alpha_1^{neg}(\tau)X_t^{neg} + \mu_t \quad (5)$$



$\theta(\tau)$ signifies the degree of convergence across different quantiles; it τ is the τ^{th} percentile, as it drives movements in response factor. $\alpha_1^{pos}(\tau)X_t^{pos}, \alpha_1^{neg}(\tau)X_t^{neg}$ represents the long-term positive (pos) and negative (neg) parameters, respectively. Cho et al. (2020) proposed that the QNARDL should first be reparametrised before the estimation in order to avoid the singularity issue.

The QNARDL model, consistent with the functional forms in Eqns. 1 and 2, is presented in Eqns. 6 and 7, respectively, subsequent to the expression in Eqn. 5.

$$\begin{aligned} \Delta LHIN_t(\tau) = & \psi_0(\tau) + \psi_1(\tau)LHIN_{t-1} + \sum_{i=0}^p \delta(\tau)\Delta LHIN_{t-1} + \sum_{i=0}^{q1} \phi_1(\tau)\Delta LIRM_{t-i}^{pos} + \sum_{i=0}^{q2} \phi_2(\tau)\Delta LFSE_{t-i} + \\ & \sum_{i=0}^{q3} \phi_3(\tau)\Delta LEXE_{t-i} + \sum_{i=0}^{q4} \phi_4(\tau)\Delta LRIR_{t-i} + \sum_{i=0}^{q5} \phi_5(\tau)\Delta LOPN_{t-i} + \sum_{i=0}^{q6} \phi_6(\tau)\Delta LINQ_{t-i} + \\ & \theta(\tau)LIRM_{neg}^{pos} + \alpha_1(\tau)LFSE + \alpha_2(\tau)LEXE + \alpha_3(\tau)LRIR + \alpha_4(\tau)LOPN + \\ & \alpha_5(\tau)LINQ + \theta(\tau)ECT + \mu_{it} \end{aligned} \quad (6)$$

$$\begin{aligned} \Delta LHIN_t(\tau) = & \psi_0(\tau) + \psi_1(\tau)LHIN_{t-1} + \sum_{i=0}^p \delta(\tau)\Delta LHIN_{t-1} + \sum_{i=0}^{q1} \phi_1(\tau)\Delta [LIRM * LFSE]_{t-i}^{pos} + \sum_{i=0}^{q2} \phi_2(\tau)\Delta LFSE_{t-i} + \\ & \sum_{i=0}^{q3} \phi_3(\tau)\Delta LEXE_{t-i} + \sum_{i=0}^{q4} \phi_4(\tau)\Delta LRIR_{t-i} + \sum_{i=0}^{q5} \phi_5(\tau)\Delta LOPN_{t-i} + \sum_{i=0}^{q6} \phi_6(\tau)\Delta LINQ_{t-i} + \\ & \theta(\tau)[LIRM * LFSE]_{neg}^{pos} + \alpha_1(\tau)LFSE + \alpha_2(\tau)LEXE + \alpha_3(\tau)LRIR + \alpha_4(\tau)LOPN + \\ & \alpha_5(\tau)LINQ + \theta(\tau)ECT + \mu_{it} \end{aligned} \quad (7)$$

Where the variables in Eqns. 6 and 7 are as defined in Eqns. 1 and 2, ECT is the error correction term, Δ = difference operator; $\Delta^p, q1, q2, q3, q4, q5$, and $q6$ signify the ideal lag values of respective variables which is designated by means of lag length information principles, μ = stochastic component. Eqns. 6 and 7 are the QNARDL-ECM models, pos and neg stand for increase and decrease in the respective threshold series, the threshold (asymmetric) series are international remittances and the interaction between remittances and financial sector efficiency. Following Shin et al. (2014), the study split the asymmetric series (LIRM and LIRM*LFSE) into positive and negative as expressed in Eqns. 8, 9, 10, and 11.

$$LIRM_t^{pos} = \sum_{i=1}^m \Delta LIRM_{t-i}^{pos} = \sum_{i=1}^n \max(\Delta LIRM_i, 0) \quad (8)$$

$$LIRM_t^{neg} = \sum_{i=1}^m \Delta LIRM_{t-i}^{neg} = \sum_{i=1}^n \max(\Delta LIRM_i, 0) \quad (9)$$

$$LIRM * LFSE_t^{pos} = \sum_{i=1}^m \Delta LIRM * LFSE_{t-i}^{pos} = \sum_{i=1}^n \max(\Delta LIRM * LFSE_i, 0) \quad (10)$$



$$LIRM * LFSE_t^{neg} = \sum_{i=1}^m \Delta LIRM * LFSE_{t-i}^{neg} = \sum_{i=1}^n \max(\Delta LIRM * LFSE_i, 0) \quad (11)$$

Because QNARDL only works reliably with series integration orders of no more than 1, figuring out the order of integration is critical. The Canova-Hansen test, which takes seasonality into account in unit root analysis, and the quantile-based unit root estimation proposed by Koenker and Xiao (2005) are both used in this study. The purpose of this action is to restrict the utilisation of the stationary processes to I(1) and I(0). Also, to check if the studied series were symmetrical across quantiles, we used the Wald test of symmetry. By rejecting the null hypothesis, we may infer that the threshold series in Eqs. 6 and 7 have an asymmetric connection, where it represents the null hypothesis.

EMPIRICAL RESULTS

Descriptive Statistics

Typically, each scientific discourse commences with descriptive statistics that establish a basis for more robust computations. Consequently, summary statistics were utilised for the relevant series in this study. This test essentially elucidates the distribution's shape and the series' behavioural pattern, among other variables. The information from the descriptive statistics indicates the regularity of the distribution of the series. Consequently, Table 2 provides a summary of the test results.

Table 2: Descriptive Statistics

	EXE	FSE	INQ	IRM	OPN	RIR
Average	165.94	11.09	16.60	4.06	36.72	15.76
Max.	391.84	20.37	27.11	9.10	53.93	24.76
Min.	10.82	5.79	6.52	0.23	14.89	10.45
Sks.	0.78	0.88	0.17	-0.10	-0.24	0.98
Kts.	2.95	3.55	1.63	1.94	2.32	2.34
J-B	10.45**	14.19**	8.64**	6.03*	3.04	13.78**

*Note: Skt., Kts, and J-B represent skewness, kurtosis, and Jarque-Bera tests respectively; **(*) signifies 1% (5%) level of significance, respectively*

The Jarque-Bera statistics in Table 2 indicate that all series, with the exception of household income (HIN) and openness (OPN), demonstrate deviations from normal distribution. The findings yield robust estimates in the context of an anomalous distribution, thus validating the selection of the quantile-based nonlinear ARDL estimation method (Koenker & Bassett, 1987; Cho et al., 2019; 2020; 2021; Odionye, 2023a; 2023b; 2024b; 2024d). The kurtosis reveals a normal peak exclusively for the exchange rate (EXE), whereas the other series display abnormal peaks. Additionally, it suggests that while other variables show a positive skew, OPN and remittances (IRM) demonstrate an inverse skew.



BDS Statistics

The estimation conducted by Broock et al. (1996), referred to as the BDS test, was employed to validate the nonlinear characteristics of the series. The estimation posits that the series demonstrates independent and identically distributed (i.i.d.) residuals, whereas the alternative hypothesis suggests that the residual series displays a deviation from conventionality, indicating nonlinear dependence.

Table 3: Summary of BDS Statistics

Dimension (m)	Variables						
	EXE	FSE	HIN	INQ	IRM	OPN	RIR
2	0.191**	0.174**	0.184**	0.181**	0.182**	0.153**	0.180**
3	0.318**	0.286**	0.307**	0.302**	0.302**	0.245**	0.298**
4	0.404**	0.354**	0.386**	0.382**	0.378**	0.292**	0.372**
5	0.463**	0.396**	0.433**	0.432**	0.426**	0.312**	0.402**
6	0.504**	0.418**	0.459**	0.461**	0.458**	0.318**	0.431**

*****(*) show rejection of null hypothesis of linearity at the 1% (5%) level of significance***

Table 3 indicates the acceptance of the alternative hypothesis and the rejection of the null hypothesis regarding the BDS in the series. The results indicate the nonlinear characteristics of the data series, requiring the use of a nonlinear methodology (Odionye et al., 2023b; al., 2025a; 2025b).

Unit Root Test

This study utilises the Canova-Hansen test, which integrates the seasonal component in unit root analysis, in conjunction with the quantile-based unit root estimation proposed by Koenker and Xiao (2005) to ascertain the integration order of the model series. The alternative hypothesis asserts that the variable lacks a unit root at a specific quantile and the seasonal component, while the unit root test maintains that the series contains a unit root. Table 4 summarises the results derived from the quantile-based unit root calculation.

Table 4: Quantile-Based and Seasonal Unit Root Tests Result

Panel A Quantile-Based Unit Root Test												
Variables	τ	5 th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th
LHIN	$\alpha(\tau)$	0.90*	0.92*	0.92*	0.94*	0.93*	0.93*	0.93*	0.94*	0.94*	0.93*	0.93*
LIRM	$\alpha(\tau)$	0.87	0.88	0.88	0.85	0.86	0.91	0.90	0.90	0.91	0.92	0.91
LFSE	$\alpha(\tau)$	0.91*	0.92	0.91*	0.92*	0.91*	0.93	0.91*	0.87*	0.87*	0.78*	0.87*
LEXE	$\alpha(\tau)$	1.04	1.01	1.01*	1.05*	1.01*	1.02*	1.01*	0.98	1.01*	1.01*	0.99*
LINQ	$\alpha(\tau)$	0.91*	1.00*	0.97*	1.01*	1.02*	1.01*	1.02*	0.96*	0.96*	0.97*	0.98*
LOPN	$\alpha(\tau)$	1.01*	1.02*	0.99*	0.99*	0.97*	0.97*	0.95*	0.97*	0.96*	0.96*	1.00
LRIR	$\alpha(\tau)$	0.81*	0.87*	0.87*	0.87*	0.88*	0.88*	0.89*	0.92	0.93*	0.94	0.95*

**** reveals t-value < CV indicating rejection of null hypothesis of unit root [$\alpha(\tau)$ (=1)] at the quantile at 5% level of significance.***

**Panel B: Canova-Hansen Seasonal Unit Root Test**

Variables	J LM	1%	5%	10%	S1	Crit	S2	Crit	S3	Crit	S4	Crit
LHIN	1.53	1.35	1.01	0.85	1.32	0.47	1.32	0.47	1.35	0.47	-	-
LIRM	1.2**	1.35	1.01	0.85	1.1	0.75	0.6**	0.75	0.4**	0.75	-	-
LFSE	1.3**	1.35	1.01	0.85	1.04	0.75	1.09	0.75	1.16	0.75	-	-
LINQ	1.92	1.35	1.01	0.85	1.28	0.75	1.56	0.75	1.45	0.75	-	-
LOPN	2.37	1.35	1.01	0.85	2.08	0.75	2.09	0.75	2.11	0.75	-	-
LRIR	1.82	1.35	1.01	0.85	1.08*	0.75	1.56	0.75	1.45	0.75	-	-

**** indicates the LM test (both joint and individual seasons) is significant at the specified frequencies/seasons at the 5% level of significance. J LM represents joint LM statistic; S represents seasons and Crit connotes the critical value for individual seasons**

Table 4 (Panel A) demonstrates that all series, with the exception of domestic investment (LIRM), exhibit level stationarity across multiple quantiles, while LIRM is characterised as level non-stationary in all quantiles. The seasonal-based stationary test of Canova-Hansen indicates level stationarity in LHIN, LINQ, and LOPN, whereas the remaining variables exhibit level non-stationarity across various seasons. The tests support the application of QNARDL, as the series exhibit fractional integration across various quantiles and seasonal periods (Cho et al., 2019; 2020; Ullah et al., 2022; Odionye et al., 2023c). The research, consistent with Cho et al. (2019; 2020), employed a two-step cointegration approach to produce the projected residual following re-parametrised estimation, thereby addressing the singularity issue. Table 5 summarises the results of the cointegration analysis.

Cointegration Test

Since the QNARDL model meets the requirement for bound cointegration, we calculate it using the framework of the model. Table 6 displays the results of QNARDL and an overview of the findings.

Table 5: Two stage Cointegration Test

Re-parameterized Estimated Residual	t-test	Significance level			Remark
		1%	5%	10%	
Baseline Model_HIN	-3.6744**	-3.456433	-2.687425	-2.540651	Cointegrated
Baseline Model_INV	-3.0983*	-3.456433	-2.687425	-2.540651	Cointegrated
Moderated Model_HIN	-4.1983**	-3.400685	-2.887425	-2.580651	Cointegrated
Moderated Model_INV	-3.5983**	-3.489659	-2.887425	-2.580651	Cointegrated

Note: ** signifies statistically significant at 1% level of significance

Table 5 demonstrates a significant long-term relationship among remittances, domestic investment and household income, as evidenced by the level stationarity of the reparameterised residual. Consequently, we evaluate the QNARDL-ECM outcome.



Lag Length Selection

The ideal lag value was guided by the lag selection principles and the outcome, in brevity, is displayed in Table 6.

Table 6: Lag length Choice based on Information Criteria

Lag	Logl	LR	FPR	AIC	SC	HQ
0	-2507.74	NA	1.34e+14	52.39	52.58	52.47
1	-1399.91	2031.02	35206.27	30.33	31.83	30.94
2	-1253.26	77.59*	239.53*	24.87*	31.10*	28.03*
3	-1230.69	34.79	8438.85	28.85	32.96	30.51
4	-1214.53	22.56	18085.69	29.53	34.95	31.72
5	-962.81	314.65	302.65	25.31	32.04	29.43
6	-892.54	247.47	4675.04	28.29	32.91	28.12

* designates lag order nominated by the condition

Table 7 shows lag 2 as the ideal lag value based on the information condition. Consequently, the QNARDL is estimated based on lag 2.

Quantile Nonlinear Autoregressive Distributed Lag (QNARDL) Result

The QNARDL technique was employed, as mentioned earlier, to ascertain the heterogeneous effects of international remittances on household income as well as the moderating influence of financial development on the enlisted connectivity in Nigeria. Table 7 provides a succinct summary of the most relevant empirical results.

Quantiles									
Panel A1 Baseline Model – Household Income (LHIN): Short-Term Outcomes									
Variables	Q_10 th	Q_20 th	Q_30 th	Q_40 th	Q_50 th	Q_60 th	Q_70 th	Q_80 th	Q_90 th
d(LHIN1(-1))	0.18**	0.16**	0.15**	0.17**	0.22**	0.24**	0.24**	0.21**	0.24**
d(LIRM_P)	0.0019	0.022	0.018	0.018	0.013*	0.0153	0.016**	0.02**	0.04**
d(LIRM_P (-1))	-0.012	-0.023	0.012	0.015	0.015	0.017	0.019	0.017*	0.018*
d(LIRM_N)	0.111	0.105	0.018	0.014	0.010	0.048	0.062	0.019	0.057
d(LFSE(-1))	0.013*	0.021*	0.021*	0.024*	0.026**	0.029**	0.031**	0.033*	0.035**
d(LINQ(-1))	0.121	0.116	0.181*	0.019	0.122	0.124*	0.132**	0.133*	0.138**
d(LOPN)	1.452	1.529	1.802	1.518	1.604	1.747	1.655	1.792	2.001
d(LEXE)	0.051	0.109	-0.017	-0.018	-0.078	-0.012	-0.095	0.079	0.046
d(LRIR)	-0.083	-0.071	-0.026	-0.029	0.1.24	-0.068	-0.070	-0.012	-0.048
ECT1(-1)	-0.045*	-0.045**	-0.052**	-0.052**	-0.054**	-0.058**	-0.057*	-0.067*	-0.169**
SR A1 Validity Test: RRT [0.78] SQT [56.76]** QSET [49.06]** WT [46.12]**									
Panel A2 Baseline Model – Household Income (LHIN): Long-Term Outcomes									
LIRM_P	0.001	0.0047	0.0041	0.0034	0.0037	0.0039	0.004	0.0042	0.0043
LIRM_N	0.01	0.017	0.041	0.034	0.037	0.039	0.040	0.042	0.050
LFSE	0.026**	0.015**	0.036**	0.053**	0.042**	0.058**	0.057**	0.054*	0.061**
LINQ	0.010	0.014	0.013	0.021	0.025**	0.023**	0.033**	0.043*	0.045**
LOPN	1.110	1.101	2.108	1.276	1.202	0.174	0.211**	0.312*	0.38**
LEXE	0.030	0.103	0.108	0.108	0.012	0.211	0.231	0.317	0.187
LRIR	0.035	-0.109	-0.201	-0.202	-0.303	-0.117	-0.143	-0.135	-0.130



LR_A2 Validity Test: RRT [2.72] SQT [35.81]** QSET [34.20]** WT [36.32]**									
Panel B1 Moderating Model – Household Income: Short-Term Outcomes									
d(LHIN(-1))	0.18**	0.16**	0.15**	0.17**	0.22**	0.24**	0.24**	0.21**	0.24**
d(LIRM*LFSE_P)	0.039**	0.039**	0.041**	0.048*	0.053**	0.061**	0.066**	0.074*	0.089**
d(LIRM*LSEP_N)	-0.012	-0.023	0.032	0.035	0.035	0.037	0.039	0.006	0.007*
d(LINQ(-1))	0.021	0.016	0.171*	0.029	0.132	0.144*	0.142**	0.143*	0.138**
d(LOPN)	1.452	1.529	1.802	1.518	1.604	1.747	1.655	1.792	2.001
d(LEXE)	0.051	0.110	0.017	-0.018	-0.078	-0.012	-0.095	0.079	0.046
d(LRIR)	-0.083	-0.071	-0.026	-0.029	0.1.24	-0.068	-0.070	-0.012	-0.048
ECT2(-1)	-0.065*	-0.055**	-0.056**	-0.057**	-0.058**	-0.061**	-0.067*	-0.077*	-0.079**
SR_B1 Validity Test: RRT [0.89] SQT [36.81]** QSET [47.90]** WT [61.34]**									
Panel B2 Moderating Model – Household Income: Long-Term Outcomes									
LIRM*LFSE_P	0.051	0.055	0.061	0.066	0.087	0.091**	0.095**	0.101*	0.134**
LIRM*LFSE_N	0.045	0.046	0.049	0.051	0.059	0.055	0.064	0.071	0.075
LINQ	0.012	0.013	0.015	0.018	0.019	0.021**	0.023**	0.053*	0.065**
LOPN	1.110	1.101	2.108	1.276	1.202	0.174	0.211**	0.312*	0.38**
LEXE	0.030	0.103	0.108	0.108	0.012	0.211	0.231	0.317	0.187
LRIR	0.035	-0.109	-0.201	-0.202	-0.303	-0.117	-0.143	-0.135	-0.130
LR_B2 Validity Test: RRT [3.31] SQT** [45.11] QSET** [46.99] WT [61.34]**									

Table 7: Summary of QNARDL Outcomes – Remittances and Household Income

*Note: ** $p < 0.01$, * $p < 0.05$. RRT denotes the Ramsey RESET test model specification, SQT epitomises the Slope Quantile test, QSE represents Quantile Slope Equality test for quantile symmetry, and WT represents the Wald test of threshold variables.*

Table 7 (Panel A1) summarises the results from the QNARDL. One interesting finding is that household income (d(LHIN (-1))) is self-reinforcing across all quantiles, among other intriguing findings. The positive and strong association between the past and present values of LHIN obviously illustrates this consequence.

Across multiple quantiles, the short-term outcome (Panel A1) regarding the mentioned regressors shows that increasing international remittances (d(LIRM_P)) significantly increases the country's household income, especially at the middle and upper quantiles (Q_50, Q_60, Q_70, Q_80, and Q_90). There appears to be a heterogeneous effect of remittances on household income (LHIN), since the size of the coefficient shows that its positive impact on LHIN increases as one moves up the quantiles. The middle and upper quantiles of the country's household income (Q_50, Q_60, Q_70, Q_80, and Q_90) are increased by 0.013%, 0.015%, 0.016%, 0.02%, and 0.04%, respectively, due to the high flow of international remittances into the country. The findings provide credence to the theoretical argument that inflow from global remittances increases household income in a country. This result aligns with what has been found for Nigeria by Anyanwu and Erhijakpor (2010) and Ajefu and Ogebe (2020), Afghanistan by Temory (2024), Central Asia by Abduvaliev and Bustillo (2020) and developing countries by Combes and Ebeke (2021). However, the reduction in remittances (d(LIRM_N)) has no significant effect on LHIN across diverse quantiles. On the other hand, the long-term results (Panel B1 – LIRM_P and LIRM_N) show inconsequential influence of both positive and negative changes in remittances on household income across all quantiles.



In relation to the financial development index (LFSE), Panel A1 shows that, in the short run, financial development increases household income in all quantiles. In specific terms, the short-term outcome demonstrates that at the 10th, 20th, ..., and 90th quantiles, the household income grows by 0.031%, 0.021%, 0.021%, 0.024%, 0.026%, 0.029%, 0.031%, 0.033%, and 0.035%, respectively, as a percentage deepens in the country's financial sector (LFSE). Similarly, across all quantiles, the financial sector boosts household income, according to the long-run outcomes (Panel A2). To be more specific, there is an increasing positive effect of financial sector development on household income, as shown by the following: a deepening of the country's financial sector enhances household income at the 10th to 90th percentiles by 0.026%, 0.015%, 0.036%, 0.053%, 0.042%, 0.058%, 0.057%, 0.054%, and 0.061%, respectively. This indicates that the country's family income is enhanced by an improved financial sector, which is a direct result of enhanced private sector credit accessibility.

In terms of the moderating influence of the financial sector on the link between remittances and household income, the short-run results (Panel B1) show that, while positive remittances (LIRM_P) increase the country's household income (Panel A1) at the middle and upper quantiles (50th, 70th, 80th, and 90th), improvements in the financial sector—an index that measures the private sector access to credit facilities—increase the effect of LIRM on household income at all quantiles. The positive and significant effect of the interaction terms between the financial sector and remittances (LIRM*LFSE_P), as shown in Panel B1, is the basis for this clear conclusion. In particular, after a 1% rise, the interaction between LIRM and LFSE significantly increases the country's family income by 0.039%, 0.039%, 0.041%, 0.048%, 0.053%, 0.061%, 0.066%, 0.074%, and 0.089% at the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th quantiles, respectively. However, the long-run estimation (Panel B2) demonstrates that the financial sector modulates the long connection between remittances and household income only at the 60th, 70th, 80th, and 90th percentile changes. What this upshot means is that a substantial improvement in the financial sector significantly improves the potential positive effect of global remittance on the country's family income. This corroborates the theoretical view that the depth and efficiency of financial institutions affect how external capital, such as remittances, is allocated (Levine, 1997). Giuliano and Ruiz-Arranz (2009) posit that, in financially developed economies, remittances are more likely to be transformed into productive use because households can access credit, save securely, and invest effectively. Thus, financial development is theorized to moderate the effect of remittances, amplifying their impact on income growth and investment.

According to the covariate results shown in Table 8 (Panels A1, A2, B1 and B2), the nation's household income across various quantiles, especially in the upper quantiles, is significantly raised by institutional quality (LINQ) and openness (LOPN). The speed of adjustment for both models (ECT1(-1) and ECT2(-1)) are appropriately signed and significant in all the quantiles, indicating a long-run convergence of the variables.

The tests of outcome validity were conducted and it indicates that, since the null hypothesis of symmetry is rejected for all models, the series is asymmetric over varied quantiles. Similarly, properly described models are indicated by the Ramsy RESET test, and considerable slope equality suggests that there is asymmetry in the slope coefficients across quantiles. According to the Wald test, there is an unbalanced relationship between the threshold variables in the capital flight threshold series.



CONCLUSION AND POLICY RECOMMENDATIONS

This study examined the heterogeneous impact of international remittances on household income in Nigeria and explored how financial sector development moderates this relationship, employing a Quantile NARDL framework. The results provide robust evidence that household income is self-reinforcing across quantiles, indicating persistence over time. In the short run, positive changes in remittance inflows significantly increase household income, particularly at the middle and upper quantiles, with the effect strengthening as one moves up the income distribution. This underscores the heterogeneous nature of remittances' impact, suggesting that higher-income households benefit more proportionally from increased remittance inflows. Conversely, negative changes in remittances exert no significant short-term or long-term effect. Financial sector development is found to have a consistently positive and significant effect on household income across all quantiles in both the short and long run, with stronger gains at higher quantiles. More importantly, the interaction results confirm that a deeper and more efficient financial sector amplifies the positive effect of remittances on household income—especially in the upper quantiles—by enhancing access to credit, encouraging savings, and enabling productive investments. Furthermore, institutional quality and trade openness also contribute positively to household income, particularly in the upper quantiles, suggesting that governance improvements and economic integration are complementary drivers of welfare gains. Diagnostic tests confirm asymmetry in the relationships, validating the use of the QNARDL approach.

The study, drawing from the empirical outcome, recommends as follows:

- 1. Promote a Deeper and More Inclusive Financial Sector:** There is a need to expand access to affordable credit, especially for low- and middle-income households, to ensure that remittance inflows are more evenly transformed into productive investments across all income groups. This includes strengthening mobile and digital banking services to reduce transaction costs and improve rural access.
- 2. Design Remittance-Linked Investment Schemes:** Introduce government-backed instruments, such as diaspora bonds, cooperative savings schemes, or matched-fund programs, that channel remittances into small business financing, housing, and infrastructure projects. Offer tax incentives or reduced transaction fees for remittance recipients who deposit and invest funds in formal financial institutions.
- 3. Enhance Institutional Quality and Governance:** Improve property rights enforcement, contract integrity, and regulatory transparency to encourage households to channel remittance resources into formal, productive ventures. Strengthen anti-corruption frameworks to ensure financial deepening benefits reach the broader population.
- 4. Leverage Trade Openness for Income Growth:** Foster export diversification and regional trade agreements that increase employment opportunities and household earning potential, thereby complementing remittance inflows. Support skills development programmes to help households participate in trade-related industries.
- 5. Address Asymmetric Effects through Targeted Interventions:** Since higher-income households benefit more from remittance inflows, targeted policies (such as concessional credit or business incubation programmes) should be implemented to help lower-income households leverage remittances productively.



6. Stabilise Remittance Flows: Establish bilateral agreements with major migrant-hosting countries to protect remittance channels during global shocks. Promote the use of official remittance transfer systems to improve reliability and capture in national statistics.

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