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The Asymmetric Associations of Foreign Aid and Remittances with Real GDP per Capita in Developing Countries: Evidence from a CS-NARDL Approach

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Abstract: This study examines the asymmetric associations of foreign aid and remittances with real GDP per capita in 68 developing countries, comprising 17 low-income countries (LICs) and 51 middle-income countries (MICs), over 1980–2023. It employs a Cross-Sectionally Augmented Nonlinear Autoregressive Distributed Lag (CS-NARDL) approach, controlling for financial development and foreign direct investment. The methodology captures asymmetric short- and long-run responses to positive and negative changes in foreign aid and remittances while accounting for cross-sectional dependence. The findings show positive coefficients on positive changes in both inflows, while the reported negative coefficients on signed decline components imply a positive predicted income response to declines in these inflows. The estimated aid associations vary more substantially across income groups, with LICs showing greater sensitivity to changes in aid flows. In the short-run, the effects are generally weaker and more heterogeneous, with growth responses to positive changes in foreign aid and remittances varying across model specifications. The expansion and contraction specifications yield different associations; their signs do not establish that external inflows cushion downturns. A supplementary Dynamic Common Correlated Effects (DCCE) specification reports broadly similar coefficient patterns. Overall, the findings underscore the importance of accounting for asymmetric responses when examining the relationship between foreign aid, remittances, and economic growth in developing countries. The findings warrant cautious policy interpretation because several estimated associations differ from the proposed economic mechanisms.

Keywords: Foreign Aid, Remittances, Economic Growth, CS-NARDL Model, Developing Countries
JEL Classification: F24, F35, F63, O11

1. Introduction

Economic growth remains a central objective of developing countries because sustained improvements in productive capacity and income are essential for raising living standards, reducing poverty, and strengthening economic resilience. Although economic growth is shaped by multiple factors, including capital accumulation, technological progress, trade openness, foreign direct investment (FDI), institutional quality, and financial development, external financial inflows can be particularly important in economies characterized by limited domestic savings and investment resources. Among these inflows, foreign aid and remittances constitute major sources of external finance that can supplement domestic resources, relax liquidity constraints, and support consumption and investment. However, their effects on economic growth remain contested in theory and in evidence. Importantly, these effects may depend not only on the level of external inflows but also on the direction of their changes. An increase in foreign aid or remittances may therefore have a different growth effect from an equivalent decrease, implying that the relationship may be asymmetric rather than linear.

Foreign aid has traditionally been viewed as an instrument for alleviating resource constraints and supporting development in recipient economies. By financing infrastructure, human capital accumulation, public services, and productive investment, aid can expand productive capacity and improve social welfare. Nevertheless, evidence concerning its contribution to economic growth remains mixed. Several studies (e.g., Burnside & Dollar, 2000; Hansen & Tarp, 2000; Dalgaard, Hansen, & Tarp, 2004; Gomanee, Girma, & Morrissey, 2005; Mishra & Newhouse, 2007; Asteriou, 2009; Bhattarai, 2009; Cai, Zheng, Hu, Pray, & Shao, 2018; Kotsadam, Østby, Rustad, Tollefsen, & Urdal, 2018; Kim & Lekhe, 2019; Jena & Sethi, 2020) argue that aid is growth-enhancing when recipient countries have sound macroeconomic policies, effective institutions, and adequate absorptive capacity, whereas others (e.g., Franco-Rodriguez, Morrissey, & McGillivray, 1998; Lensink & White, 2001; Islam, 2005; Jensen & Paldam, 2006; Bird & Choi, 2020) emphasize potential adverse effects arising from dependency, weak incentives for domestic resource mobilization, and inefficient allocation. These contrasting perspectives suggest that aid effectiveness may depend on the institutional and macroeconomic environment in which it is received. More importantly, evidence that aid effectiveness varies with the magnitude and direction of changes in aid suggests that conventional estimates of an average linear effect may not adequately capture the aid–growth relationship. Remittances have similarly become an increasingly important source of external finance for developing economies. At the household level, remittances can relax liquidity constraints and finance consumption, education, healthcare, housing, savings, and productive

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activities. At the macroeconomic level, they can supplement domestic savings, stimulate aggregate demand, facilitate investment, and potentially strengthen financial intermediation.

However, the growth implications of remittances are also ambiguous. Their effects depend partly on how recipient households allocate the funds and on the ability of domestic financial and institutional systems to channel resources toward productive activities. Existing evidence (e.g., Senbeta, 2013; Kratou & Gazdar, 2015; Adams & Klobodu, 2016; Meyer & Shera, 2017; Olayungbo & Quadri, 2019; Sutradhar, 2020; Odugbesan, Sunday, & Olowu, 2021; Islam, 2024; Garcia-Fuentes, Kennedy, & Ferreira, 2025) reports positive, negative, and heterogeneous effects across countries and time horizons. This variation suggests that increases and decreases in remittance inflows may not have equivalent effects on economic activity. The potential asymmetry between foreign aid and remittances is particularly important for developing economies exposed to global economic and financial shocks. International crises, geopolitical conflicts, health emergencies, natural disasters, and changes in global economic conditions can generate substantial fluctuations in external financial flows. A reduction in aid may constrain public investment or disrupt development programs, while a decline in remittances may reduce household income and weaken consumption and investment. Conversely, an increase in these inflows may not generate an equivalent positive response if additional resources are directed toward consumption, precautionary savings, or other non-productive uses. Consequently, imposing symmetric responses to positive and negative changes may conceal important differences in the adjustment process and provide an incomplete picture of the relationship between external financial inflows and economic growth.

Despite the extensive literature on foreign aid, remittances, and economic growth, several important issues remain insufficiently addressed. First, much of the existing evidence examines foreign aid and remittances separately or within conventional linear frameworks, leaving limited evidence on whether positive and negative changes in both inflows generate asymmetric growth responses within a unified framework. Second, the effects of external financial inflows may differ across countries at different levels of economic development because low-income and middle-income economies vary in their dependence on external finance, financial-system development, institutional capacity, and ability to absorb external resources. Third, developing countries face common global shocks, creating potential cross-sectional dependence, while country-specific characteristics may generate heterogeneous adjustment processes. Ignoring these features may lead to incomplete conclusions regarding the dynamic relationship between external financial inflows and economic growth.

Against this background, this study examines the asymmetric effects of foreign aid and remittances on economic growth in 68 developing countries from 1980 to 2023. The outcome is real GDP per capita, so the level estimates concern income per person. The analysis decomposes foreign aid and remittances into positive and negative changes to distinguish the effects of increases from those of decreases. It examines both short-run and long-run relationships and whether they differ between low-income and middle-income countries. Financial development and FDI are included as additional explanatory variables because domestic financial conditions and external investment may influence both economic performance and countries' capacity to absorb external financial resources. The empirical analysis employs the Cross-Sectionally Augmented Nonlinear Autoregressive Distributed Lag (CS-NARDL) framework to investigate asymmetric dynamic relationships while accounting for cross-sectional dependence and heterogeneous country responses. The study then uses Dynamic Common Correlated Effects (DCCE) estimation as a complementary robustness check to assess the stability of the main findings.

The study makes three principal contributions to the literature. First, it examines foreign aid and remittances jointly within an asymmetric framework, thereby allowing the growth effects of positive and negative changes in both inflows to be identified and compared. This approach moves beyond the conventional assumption that increases and decreases in external financial inflows have proportionate and opposite effects. Second, it investigates whether the asymmetric relationships differ between low-income and middle-income countries, providing evidence on whether the growth implications of external finance vary with countries' levels of economic development. Third, the study incorporates cross-sectional dependence into the empirical analysis and employs DCCE estimation as a complementary robustness check. By combining these dimensions, the study provides a broader assessment of how external financial inflows affect economic growth under heterogeneous country conditions.

Accordingly, the study addresses the following research questions: (*i*) Do positive and negative changes in foreign aid and remittances have asymmetric effects on economic growth in developing countries, and do these effects differ between the short-run and the long-run?, (*ii*) Do the short-run and long-run growth effects of positive and negative changes in foreign aid and remittances differ between low-income and middle-income countries?, (*iii*) To what extent are the estimated relationships between foreign aid, remittances, and economic growth robust to cross-sectional dependence, heterogeneous country characteristics, and the inclusion of FDI and financial development?

The remainder of the paper is organised as follows. Section 2 reviews the theoretical and empirical literature on foreign aid, remittances, and economic growth and develops the research hypotheses. Section 3 describes the data, variables, and econometric methodology. Section 4 presents and discusses the empirical findings, including the income-group analysis and robustness checks. Section 5 concludes the study and discusses its policy implications.

2. Literature Review

2.1. Foreign Aid and Economic Growth

The relationship between foreign aid and economic growth has long been debated in development economics. Theoretically, foreign aid can contribute to growth by easing savings and foreign-exchange constraints, financing infrastructure and human capital, and supporting productive investment in economies with insufficient domestic resources. The traditional two-gap framework suggests that external resources can help overcome both domestic savings constraints and foreign-exchange shortages, thereby facilitating capital accumulation and economic expansion. However, aid effectiveness depends on how well recipient economies allocate and absorb these resources. Empirical evidence has produced competing conclusions. Burnside and Dollar (2000) and Hansen and Tarp (2000)argue that aid is more effective in countries characterised by sound macroeconomic policies and favourable institutional conditions. Dalgaard et al. (2004) further suggest that the relationship between aid and growth can depend on broader structural and geographic conditions. Bhattarai (2009), Cai et al. (2018), Kim

and Lekhe (2019), and Jena and Sethi (2020) also provide evidence that institutional and macroeconomic conditions shape aid effectiveness.

However, a substantial body of literature has challenged the positive interpretation of aid effectiveness. Lensink and Morrissey (2000), Hansen and Tarp (2001), Lensink and White (2001), Easterly, Levine, and Roodman (2004), Ali and Isse (2005), Islam (2005), and Jensen and Paldam (2006) demonstrate that the estimated relationship between aid and growth can be sensitive to model specification, sample selection, and methodological assumptions. Easterly (2003) and Easterly (2007), in particular, question whether sustained aid inflows necessarily generate the productivity improvements required for long-term growth. Potential adverse mechanisms include aid dependency, weakened incentives for domestic revenue mobilisation, inefficient resource allocation, and institutional distortions. Thus, the empirical literature has not reached consensus on the average growth effect of foreign aid.

More recent research has moved beyond the assumption of a constant linear aid–growth relationship. Yiew and Lau (2018), for example, identify nonlinear effects and suggest that aid's growth consequences may vary by magnitude. Their findings imply that aid may have different effects at different levels of inflows, highlighting the importance of considering nonlinearities when evaluating aid effectiveness. Other studies emphasize the role of absorptive capacity and complementary domestic conditions. Cao and Du (2024), using data for 128 countries over 2000–2019, identify a U-shaped relationship between foreign aid and economic growth and report that absorptive capacity positively moderates this relationship. Ofori, Ojong, and Gbolonyo (2024), examining 41 Sub-Saharan African countries, find that foreign aid contributes to inclusive growth and that transport infrastructure strengthens this effect. Legass and Akkas (2025), using panel ARDL techniques for 15 Sub-Saharan African countries, also report significant long-run relationships involving official development assistance and economic growth while emphasizing the relevance of institutional and macroeconomic conditions.

An emerging strand of the literature has specifically considered whether positive and negative changes in aid produce asymmetric effects. Asaleye, Ojo, and Olagunju (2023), examining Nigeria, find evidence that positive aid shocks are associated with higher long-run economic growth, whereas negative shocks are associated with lower growth. Doerr (2025) provides further evidence that the growth effects associated with aid may be driven more strongly by the consequences of aid reductions than by the benefits of aid increases. Similarly, Vaswani and Padmaja (2026), using a nonlinear ARDL framework for India, find significant responses to negative grant shocks, while positive grant and loan shocks are not statistically significant. These findings challenge the conventional assumption that increases and decreases in aid have symmetric effects and suggest that reductions in external assistance may generate consequences that are not simply the mirror image of those associated with increases. Overall, the literature suggests that the aid–growth relationship depends on the magnitude and direction of aid changes, absorptive capacity, institutional quality, and broader economic conditions. Nevertheless, evidence on asymmetric aid effects remains geographically concentrated and is often based on individual countries or specific regional samples. Consequently, evidence remains limited on whether asymmetric aid effects are systematic across a broad group of developing countries and whether they differ by income level.

2.2. Remittances and Economic Growth

Remittances are an important source of external finance in developing economies. They can raise household income, ease liquidity constraints, and support education, healthcare, consumption, savings, and investment. Their growth effects, however, depend on how recipients use remittances and on recipient economies' institutional and financial conditions. Several studies report positive effects of remittances on economic growth. Karagöz (2009), Buch and Kuckulenz (2010), Quartey and Adamba (2015), Oshota and Badejo (2015), and Odugbesan and Rjoub (2019) provide evidence supporting remittances' growth-enhancing role. Javid, Arif, and Qayyum (2012), Meyer and Shera (2017), and Sutradhar (2020) similarly identify positive relationships between remittances and growth in developing and emerging economies. These findings align with the view that remittances can ease household financing constraints and support investment and consumption. Nevertheless, the literature also demonstrates that the effects of remittances are not uniform across countries or time horizons. Olayungbo, Olaniyi, and Ojeyinka (2020) and Golder, Rumaly, Hossain, and Nigar (2023) report that remittances can stimulate economic growth in the short-run while producing mixed or adverse effects over longer horizons. Kratou and Gazdar (2015) and Ben Mim and Ben Ali (2021) similarly identify differences between short-run and long-run effects in MENA economies. Such findings suggest that remittances may operate through competing channels. In the short-run, transfers may stimulate consumption and aggregate demand, whereas their longer-run effects may depend on whether they are directed toward productive investment, human capital accumulation, or savings.

Evidence also differs across regions and country groups. Pradhan (2016), Odugbesan and Rjoub (2019), and Sutradhar (2020) document heterogeneous relationships across emerging, MINT, and South Asian economies. Cazachevici, Havranek, and Horvath (2020) find a modest positive effect of remittances on growth, while Senbeta (2013) emphasizes their contribution to capital accumulation but identifies more limited effects on productivity. Olayungbo and Quadri (2019) report positive short- and long-run effects for selected African countries. These differences suggest that country-specific financial, institutional, and structural characteristics shape the growth consequences of remittances. More recent studies have increasingly emphasized nonlinear and asymmetric effects. Glytsos (2005) argues that fluctuations in remittance flows can generate uneven effects on economic activity, implying that increases and decreases in transfers may not have equivalent consequences. Odugbesan et al. (2021), using a nonlinear ARDL framework for MINT countries, find evidence that positive and negative remittance shocks are associated with economic growth, although the estimated effects do not necessarily imply symmetric adjustment. Kumar and Mohnot (2024) further show that remittance effects can vary with the business cycle, finding different responses during periods of economic expansion and recession.

Recent cross-country evidence reinforces the importance of heterogeneity. Islam (2024), examining 20 major remittance-receiving countries over the period 1996–2021 using CCEMG and AMG estimators, reports a negative association between remittances and economic growth, emphasizing the role of broader economic and institutional conditions. In contrast, Garcia-Fuentes et al. (2025), using a panel of 103 countries from 1990–2019 and accounting for potential endogeneity, find a positive relationship between remittances and growth. Hamdaoui, Amairia, and Abdejlil (2026), using ARDL and CS-ARDL approaches for 48 countries, report a positive association between remittances and economic growth in developing countries

while finding differences between developing and developed economies. They further highlight the role of governance in shaping the growth effects of remittances. Taken together, the evidence indicates that the remittance–growth relationship varies across countries, time horizons, and economic conditions. Although the literature increasingly recognizes nonlinear and asymmetric effects, relatively limited evidence simultaneously examines positive and negative changes in remittances across a broad sample of developing countries while accounting for cross-sectional dependence and differences in income levels.

2.3. Research Gap

The preceding literature demonstrates that neither foreign aid nor remittances has a uniform effect on economic growth. However, several important gaps remain. First, although recent studies have begun to examine nonlinear and asymmetric effects, the evidence remains fragmented. Existing research often focuses on either foreign aid or remittances rather than examining both sources of external finance within a unified asymmetric framework. Consequently, evidence remains limited on whether positive and negative changes in these two major external financial inflows produce comparable or distinct growth responses. Second, much of the asymmetric evidence comes from individual countries or specific regional samples. This limits the extent to which existing findings can be generalized across developing economies and provides relatively little evidence on whether the growth effects of positive and negative external financial shocks differ systematically between low-income and middle-income countries. Differences in financial development, institutional capacity, dependence on external finance, and domestic resource mobilization may lead countries at different income levels to respond differently to changes in aid and remittances. Third, the empirical literature has not sufficiently integrated asymmetry with cross-sectional dependence and heterogeneous country responses. Developing countries face common global shocks that can simultaneously affect external financial flows and domestic economic activity. Failure to account for such common factors may bias estimated relationships. Moreover, the adjustment process may differ across countries, making homogeneous panel estimates potentially inappropriate.

2.4. Research Hypotheses

The theoretical arguments and empirical evidence reviewed above suggest that the effects of foreign aid and remittances may differ according to the direction of changes in these inflows and across country groups. Accordingly, the study formulates the following hypotheses:

H1: *Positive and negative changes in foreign aid have asymmetric effects on economic growth in developing countries in the short-run and/or long-run.*

H2: *Positive and negative changes in remittances have asymmetric effects on economic growth in developing countries in the short-run and/or long-run.*

H3: *The asymmetric effects of foreign aid on economic growth differ between low-income and middle-income countries.*

H4: *The asymmetric effects of remittances on economic growth differ between low-income and middle-income countries.*

3. Data and Methodology

3.1. Data Description

The empirical analysis covers 68 developing countries from 1980–2023. The sample comprises 17 low-income countries (LICs) and 51 middle-income countries (MICs), allowing the analysis to examine whether the relationships between foreign aid, remittances, and economic growth differ across income groups. The countries included in each group are listed in Table A1 of Appendix. The study uses annual data on real GDP per capita, official development assistance (ODA), remittances (REM), foreign direct investment (FDI), and financial development (FD). Real GDP per capita is used as a proxy for economic growth, while ODA and REM are the principal external financial flows of interest. FDI and FD are included as control variables to account for other potential determinants of economic growth. Data on real GDP per capita, REM, FDI, and FD come from the World Bank's World Development Indicators (WDI) database (World Bank, 2023), while ODA data come from the OECD Creditor Reporting System (CRS). Table 1 presents the variable definitions and data sources.

Table 1. Variable definitions and data sources.

Variables	Abbreviation	Definition	Data source
Real GDP per capita	GDPpc	Real GDP per capita (constant 2015 US dollars)	WDI
Remittances	REM	Personal remittances received (% of GDP)	WDI
Foreign direct investment	FDI	Foreign direct investment, net inflows (% of GDP)	WDI
Financial development	FD	Domestic credit to the private sector (% of GDP)	WDI
Foreign aid	ODA	Foreign aid per capita, also known as official development assistance per capita (constant 2015 US dollars)	CRS-OECD

Source: Author's compilation.

Note: WDI = World Development Indicators. CRS = Creditor Reporting System. OECD = Organization for Economic Co-operation and Development.

The FDI, ODA, and REM dataset contains zeros and, in some cases, negative observations. Because the conventional natural logarithm is undefined for zero and negative values, applying a standard logarithmic transformation would require excluding these observations, potentially reducing the sample size and affecting the panel's composition. To address this issue, we applied the inverse hyperbolic sine (IHS) transformation, defined as: $arsinh(x) = ln(x + \sqrt{x^2 + 1})$, where x represents the original variable. This transformation accommodates positive, zero, and negative values while preserving each observation's

sign. We applied it consistently across countries and years to FDI, ODA, and REM. We then used the resulting transformed series to construct the positive and negative partial sums required for the nonlinear specification.

3.2. Methodology

Panel data analyses may be affected by cross-sectional dependence (CD), slope heterogeneity, and non-stationarity, particularly when the sample comprises economically interconnected countries. Ignoring these features may bias estimates and undermine statistical inference. Accordingly, the empirical strategy begins with diagnostic tests to assess panel characteristics before estimating short- and long-run relationships using the CS-NARDL framework. First, we examine cross-sectional dependence using the Breusch–Pagan Lagrange Multiplier (LM) test proposed by Breusch and Pagan (1980), the Pesaran scaled LM test, and the Pesaran CD test (2004). These tests assess whether disturbances across countries are correlated, potentially reflecting exposure to common global, regional, or economic shocks. Evidence of CD indicates that cross-sectional linkages should be considered when selecting appropriate estimation and inference procedures. Second, we assess slope homogeneity using the test proposed by Pesaran and Yamagata (2008). This test examines whether the slope coefficients are homogeneous across countries. Evidence of slope heterogeneity suggests that countries may respond differently to changes in the explanatory variables, supporting an estimation framework that allows heterogeneous, country-specific relationships. Third, the stationarity properties of the variables are examined using the Cross-sectionally Augmented Dickey–Fuller (CADF) panel unit root test proposed by Pesaran (2007). This second-generation approach incorporates cross-sectional averages to account for common factors and cross-sectional dependence. The unit root analysis is used to determine the order of integration of the variables and to ensure that none is integrated of order two, I(2), as the CS-NARDL framework applies to variables that are I(0) and/or I(1), but not I(2).

Following the unit root analysis, the panel cointegration test proposed by Westerlund (2007) examines the existence of a long-run relationship among the variables. This approach allows for heterogeneous dynamics, and its ability to account for cross-sectional dependence depends on the specific implementation and inference procedure employed. The empirical analysis then examines whether changes in foreign aid and remittances are asymmetrically associated with economic growth. To do so, the transformed ODA and REM series are decomposed into positive and negative partial sums. This decomposition allows separate estimation of the short- and long-run relationships associated with increases and decreases in these financial flows. The baseline functional relationship between economic growth and the explanatory variables is specified as follows:

$$lnGDPpc_{it} = f(lnODA_{it}, lnREM_{it}, lnFDI_{it}, lnFD_{it}) \tag{1}$$

where $i = 1, \ldots, 68$ denotes country and $t = 1980, \ldots, 2023$ denotes time period. lnGDPpc denotes the natural logarithm of real GDP per capita, and lnFD denotes the natural logarithm of financial development. The aid, remittance, and FDI variables are labeled lnODA, lnREM, and lnFDI in the equations and tables, but are described above as inverse hyperbolic sine transformations rather than natural logarithms. To investigate asymmetric effects, lnODA and lnREM are decomposed into their positive and negative changes. Following the nonlinear ARDL approach proposed by Shin, Yu, and Greenwood-Nimmo (2014), the positive and negative partial sums are defined as:

$$\begin{aligned} lnODA_{it} &= lnODA^{+}_{it} + lnODA^{-}_{it} \\ lnREM_{it} &= lnREM^{+}_{it} + lnREM^{-}_{it} \end{aligned} \tag{2}$$

where:

$$\begin{aligned} lnODA^{+}_{it} &= \sum_{j=1}^{t} max(\Delta lnODA_{ij}, 0); \; lnODA^{-}_{it} = \sum_{j=1}^{t} min(\Delta lnODA_{ij}, 0) \\ lnREM^{+}_{it} &= \sum_{j=1}^{t} max(\Delta lnREM_{ij}, 0); \; lnREM^{-}_{it} = \sum_{j=1}^{t} min(\Delta lnREM_{ij}, 0) \end{aligned} \tag{3}$$

The long-run asymmetric model becomes:

$$lnGDPpc_{it} = \alpha_i + \beta^{+}_1 lnODA^{+}_{it} + \beta^{-}_1 lnODA^{-}_{it} + \beta^{+}_2 lnREM^{+}_{it} + \beta^{-}_2 lnREM^{-}_{it} + \beta_3 lnFDI_{it} + \beta_4 lnFD_{it} + \epsilon_{it} \tag{4}$$

This specification tests whether increases and decreases in ODA and REM have different effects on real GDP per capita.

For a panel with cross-sectional dependence, the CS-NARDL error-correction can be expressed generally as:

$$\begin{aligned} \Delta lnGDPpc_{it} = {} & \varnothing_i (lnGDPpc_{i,t-1} - \theta^{+}_1 lnODA^{+}_{i,t-1} - \theta^{-}_1 lnODA^{-}_{i,t-1} - \theta^{+}_2 lnREM^{+}_{i,t-1} - \theta^{-}_2 lnREM^{-}_{i,t-1} \\ & - \theta_3 lnFDI_{i,t-1} - \theta_4 lnFD_{i,t-1}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta lnGDPpc_{i,t-j} + \sum_{j=0}^{q-1} (\delta^{+}_{1ij} \Delta lnODA^{+}_{i,t-j} + \delta^{-}_{1ij} \Delta lnODA^{-}_{i,t-j}) \\ & + \sum_{j=0}^{q-1} (\delta^{+}_{2ij} \Delta lnREM^{+}_{i,t-j} + \delta^{-}_{2ij} \Delta lnREM^{-}_{i,t-j}) + \sum_{j=0}^{q-1} \delta_{3ij} \Delta lnFDI_{i,t-j} + \sum_{j=0}^{q-1} \delta_{4ij} \Delta lnFD_{i,t-j} + \gamma_i' \underline{Z}_t + \mu_i + \epsilon_{it} \end{aligned} \tag{5}$$

where Δ denotes the first-difference operator, p and q denote the lag orders of the dependent and explanatory variables, respectively, and $\varnothing_i$ is the error-correction coefficient. The parameters θ represent the long-run coefficients, whereas the λ and δ coefficients capture the short-run dynamics. The country-specific intercept is represented by μ_i, and ϵ_{it} denotes the error term. The vector $\underline{Z}_t$ represents the cross-sectional averages of the model variables at time t, including GDP per capita, ODA, REM, FDI, and FD. These cross-sectional averages are incorporated into the CS-NARDL model to capture unobserved common factors and account for cross-sectional dependence across the developing countries in the panel. Formally, $\underline{Z}_t = (\underline{GDPpc}_t, \underline{ODA}_t, \underline{REM}_t, \underline{FDI}_t, \underline{FD}_t)'$.The coefficient $\varnothing_i$ captures the speed of adjustment toward the long-run

equilibrium relationship. A statistically significant and negative value of $\varnothing_i$ indicates that deviations from the long-run equilibrium are corrected over time, thereby confirming the existence of a stable long-run relationship among the variables.

The long-run effects of positive and negative changes in lnODA and lnREM are captured by $\theta_1^+, \theta_2^+, \theta_1^-$ and θ_2^-, respectively. We evaluate long-run and short-run symmetry using Wald restrictions. For lnODA, we evaluate long-run symmetry by testing whether the coefficients on positive and negative changes are statistically equal. The same procedure is applied to lnREM. If the null hypothesis of equality is rejected, the evidence supports asymmetric effects, indicating that increases and decreases in the respective variable have statistically different effects on economic growth. The Wald tests therefore complement the nonlinear specification by formally determining whether the effects of positive and negative changes differ. The CS-NARDL framework offers several advantages over conventional panel estimators, including pooled nonlinear ARDL, Fully Modified Ordinary Least Squares (FMOLS), and Dynamic Ordinary Least Squares (DOLS). First, it accounts for cross-sectional dependence by incorporating cross-sectional averages, thereby controlling for unobserved common factors. Second, it allows for heterogeneous slope coefficients across countries rather than imposing a common response. Third, the CS-ARDL framework can accommodate regressors that are a mixture of I(0) and I(1) processes, provided that none of the variables is I(2). Finally, decomposing lnODA and lnREM into positive and negative components allows the analysis to capture potentially asymmetric short-run and long-run effects that a conventional linear specification may not identify.

4. Results and Discussion

4.1. Descriptive Statistics and Correlation

Table 2 reports descriptive statistics of the study variables. The descriptive statistics indicate substantial variation across the 68 developing countries over the sample period. The mean of lnGDPpc is 7.917, with values ranging from 5.199 to 9.610, indicating considerable differences in income levels across the sampled countries. The explanatory variables also exhibit meaningful dispersion, with standard deviations ranging from 0.972 for lnFDI to 1.270 for lnREM. The skewness statistics indicate that lnGDPpc, lnFD, and lnFDI are mildly negatively skewed, whereas lnODA and lnREM are mildly positively skewed. The kurtosis values range from 2.438 to 3.134 and are relatively close to three, suggesting no substantial departure from normal kurtosis. The Jarque–Bera test results further indicate that the null hypothesis of normality cannot be rejected at the 5% significance level for any variable, as all reported p-values exceed 0.05.

Table 2. Descriptive statistics.

	lnGDPpc	lnFD	lnFDI	lnODA	lnREM
Mean	7.917	3.233	0.768	3.768	1.604
Maximum	9.610	5.115	3.835	6.708	5.464
Minimum	5.199	-0.909	0.000	0.000	-2.302
Std. Dev.	0.784	1.077	0.972	1.167	1.270
Skewness	-0.175	-0.215	-0.642	0.305	0.421
Kurtosis	2.529	2.438	3.134	2.772	2.615
Jarque-Bera (p-value)	0.642	0.613	0.275	0.692	0.528
Obs.	2992	2992	2992	2992	2992

Source: Author's own estimation using Stata 17.0.

The pairwise correlation coefficients reported in Table 3 reveal several notable relationships among the variables. The results show that lnFD and lnFDI are positively correlated with lnGDPpc, with correlation coefficients of 0.524 and 0.485, respectively. In contrast, lnODA and lnREM exhibit negative correlations with lnGDPpc, with coefficients of −0.270 and −0.125, respectively. Among the explanatory variables, the pairwise correlation coefficients range from −0.245 to 0.372, with the strongest positive association observed between lnFD and lnFDI.

Table 3. Correlation matrix.

Variables	lnGDPpc	lnFD	lnFDI	lnODA	lnREM
lnGDPpc	1.000				
lnFD	0.524***	1.000			
lnFDI	0.485***	0.372***	1.000		
lnODA	-0.270**	-0.245**	0.286**	1.000	
lnREM	-0.125**	0.261**	0.318***	0.252**	1.000

Source: Author's own estimation using Stata 17.0.

*Note: ** and *** denote statistical significance at the 5% and 1% levels, respectively.*

Overall, the correlation matrix indicates that the explanatory variables do not exhibit strong pairwise correlations, as none of the coefficients exceeds 0.90. This provides preliminary evidence that serious multicollinearity is unlikely. Nevertheless, pairwise correlations alone are insufficient to fully assess multicollinearity; therefore, the Variance Inflation Factor (VIF) test is employed as an additional diagnostic, with the corresponding results reported in Table A2 of Appendix.

4.2. Cross-sectional Dependence Test

This study examines cross-sectional dependence (CD) before conducting the panel data analysis. Accordingly, this study employs three widely used tests: the Breusch-Pagan LM test (Breusch & Pagan, 1980), the Pesaran scaled LM test (CD_{LM}), and the Pesaran CD test (2004). The null hypothesis of each test is that the panel units are cross-sectionally independent. The results, reported in Table 4, consistently reject the null hypothesis of cross-sectional independence at the 1% significance level for all variables, indicating significant CD among the sample countries. These findings suggest that the countries may

be influenced by common global and regional shocks arising from increasing economic integration, such as global financial crises, fluctuations in commodity and oil prices, globalisation, and changes in international aid and capital flows.

Table 4. Cross-sectional dependence test.

	LM test		CD_{LM} test		CD test	
	Statistic	p-value	Statistic	p-value	Statistic	p-value
lnGDPpc	3828.750***	0.000	22.975***	0.000	10.732***	0.000
lnODA	3373.830***	0.000	16.235***	0.000	3.918***	0.000
lnREM	3634.370***	0.000	20.095***	0.000	3.846***	0.000
lnFDI	3723.070***	0.000	21.409***	0.000	3.760***	0.000
lnFD	4216.030***	0.000	28.712***	0.000	8.495***	0.000

Source: Author's own estimation using Stata 17.0.

*Note: The null hypothesis for all tests is cross-sectional independence. *** denotes statistical significance at the 1% level.*

4.3. Slope Heterogeneity Test

Table 5 presents the results of the Pesaran and Yamagata (2008) slope heterogeneity test. Both the standard Δ^ and adjusted $\hat{\Delta}_{adj}$test statistics are positive and statistically significant at the 1% level. Therefore, we reject the null hypothesis of slope homogeneity, providing strong evidence of slope coefficient heterogeneity across the sampled countries. This finding indicates that the effects of ODA, REM, FDI, and FD on real GDP per capita vary across cross-sectional units. Accordingly, cross-sectional parameter heterogeneity supports estimation techniques that account for country-specific slope variations, such as the CS-NARDL framework.

Table 5. Slope heterogeneity test.

	Statistic	p-value
$\hat{\Delta}$	16.502***	0.000
$\hat{\Delta}_{adj}$	17.348***	0.000

Source: Author's own estimation using Stata 17.0.

*Note: Δ and Δadj denote the standard and adjusted slope homogeneity test statistics, respectively. *** indicates statistical significance at the 1% level.*

4.4. Panel Unit Root Test

Table 6 reports the results of the CADF panel unit root test proposed by Pesaran (2007) for the full sample and the two income-group subsamples, namely low-income countries (LICs) and middle-income countries (MICs). We conduct the test under both intercept and intercept-and-trend specifications, selecting optimal lag lengths using the Akaike Information Criterion (AIC). For the full sample, the results indicate that lnODA is stationary in levels, I(0), under both specifications, as its CADF statistics are statistically significant. In contrast, lnGDPpc, lnREM, lnFDI, and lnFD are non-stationary at levels but become stationary after first differencing, indicating that these variables are I(1). For the LICs, lnFDI is stationary at levels under both specifications, implying that it is I(0). The remaining variables—lnGDPpc, lnODA, lnREM, and lnFD—become stationary after first differencing, indicating that they are I(1). For the MICs, lnODA is stationary at levels under both specifications and is therefore I(0). The other variables—lnGDPpc, lnREM, lnFDI, and lnFD—are stationary only after first differencing.

Table 6. CADF panel unit root test.

Variables	I(0)		I(1)		Order of Integration
	Intercept	Intercept & trend	Intercept	Intercept & trend	
Full sample					
lnGDPpc	-1.785	-2.482	-5.346***	-5.468***	I(1)
lnODA	-3.483***	-3.801**	—	—	I(0)
lnREM	-1.597	-2.078	-4.665***	-6.372***	I(1)
lnFDI	-2.754	-2.315	-6.795***	-6.391***	I(1)
lnFD	-2.305	-1.682	-6.457***	-6.842***	I(1)
LICs					
lnGDPpc	-1.675	-2.982	-5.836***	-6.012***	I(1)
lnODA	-3.132	-3.673	-6.263***	-6.392***	I(1)
lnREM	-1.968	-1.251	-6.196***	-5.705***	I(1)
lnFDI	-2.705**	-1.552*	—	—	I(0)
lnFD	-2.309	-1.534	-6.195***	-6.463***	I(1)
MICs					
lnGDPpc	-1.854	-2.248	-5.180***	-5.285***	I(1)
lnODA	-3.492***	-3.805**	—	—	I(0)
lnREM	-2.544	-1.746	-4.833***	-6.115***	I(1)
lnFDI	-2.845	-2.413	-6.709***	-6.542***	I(1)
lnFD	-2.475	-1.682	-7.185***	-7.831***	I(1)

Source: Author's own estimation using Stata 17.0.

*Note: *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.*

Overall, the CADF results reveal a mixed order of integration, comprising I(0) and I(1) variables, across the full sample and the income-group subsamples. Importantly, none of the variables is integrated of order two, I(2).

4.5. Panel Cointegration Test

To examine whether a long-run equilibrium relationship exists among the variables, this study employs the panel cointegration test proposed by Westerlund (2007). Unlike conventional residual-based panel cointegration tests, the Westerlund approach is based on the significance of the error-correction term and allows for heterogeneity across panel units. Following Westerlund (2007), we use bootstrapped p-values to account for cross-sectional dependence among panel units. The results reported in Table 7 reject the null hypothesis of no cointegration. Specifically, the panel statistics (Pτ and Pα) are statistically significant at the 1% level for the full sample and both the MIC and LIC subsamples. These findings provide strong evidence of a long-run cointegrating relationship among the variables. The evidence of cointegration, together with the mixed order of integration and the presence of cross-sectional dependence and slope heterogeneity, supports applying the CS-NARDL framework to estimate the asymmetric long-run relationships and associated short-run adjustment dynamics.

Table 7. Westerlund cointegration test.

	Full sample			MICs			LICs		
Statistic	**Value**	**z-value**	**p-value**	**Value**	**z-value**	**p-value**	**Value**	**z-value**	**p-value**
Gτ	-1.649	-1.731	1.000	-1.476	-2.972	1.000	-3.696	-1.154	1.000
Gα	-6.213	1.499	1.000	-5.851	-1.524	1.000	-8.768	1.760	1.000
Pτ	-22.736***	-1.236	0.000	-20.182***	-2.093	0.000	-22.625***	-2.756	0.000
Pα	-11.083***	1.265	0.000	-10.581***	-1.713	0.000	-12.808***	-3.912	0.000

Source: Author's own estimation using Stata 17.0.

*Note: Gτ and Gα are group-mean test statistics; Pτ and Pα are panel test statistics. Reported p-values are robust p-values obtained via bootstrapping with 1,000 replications to account for cross-sectional dependence across panel units. *** indicate significance at the 1% level, respectively.*

4.6. CS-NARDL Model Results

The preceding analysis established evidence of asymmetry in the relationship between external financial flows and real GDP per capita. To investigate this asymmetry formally, we decompose lnODA and lnREM into positive and negative partial sums, denoted by $\ln ODA^{+}$, $\ln ODA^{-}$, $\ln REM^{+}$, and $\ln REM^{-}$. The Wald test reported in Table A3 of of Appendix rejects the null hypothesis of long-run and short-run symmetry for the full sample, as well as for MICs and LICs. These results indicate that positive and negative changes in ODA and REM inflows are associated with statistically different responses in real GDP per capita. Table 8 reports the estimated long-run and short-run CS-NARDL coefficients. The results provide consistent evidence of asymmetric relationships between ODA, REM, and real GDP per capita.

Table 8. Long-run and short-run CS-NARDL results.

	Full sample			MICs			LICs		
Variables	**Coeff.**	**Z-stat.**	**P-value**	**Coeff.**	**Z-stat.**	**P-value**	**Coeff.**	**Z-stat.**	**P-value**
Long-run estimates									
$\ln ODA^{+}$	0.465***	2.576	0.010	0.470**	1.971	0.049	0.559***	4.142	0.000
$\ln ODA^{-}$	-0.178***	-2.660	0.008	-0.212*	-1.702	0.089	-0.401**	-1.985	0.047
$\ln REM^{+}$	0.331***	2.652	0.008	0.342**	1.990	0.047	0.328***	2.601	0.009
$\ln REM^{-}$	-0.165**	-2.011	0.044	-0.154**	-2.031	0.042	-0.148**	-2.064	0.039
lnFDI	0.548**	2.172	0.030	0.591**	1.977	0.048	0.485**	1.982	0.047
lnFD	0.527**	2.027	0.043	0.562**	1.966	0.049	0.541**	1.995	0.046
Short-run estimates									
$\Delta\ln ODA^{+}$	0.050*	1.918	0.055	0.046*	1.812	0.070	0.055**	2.005	0.045
$\Delta\ln ODA^{-}$	-0.022*	-1.881	0.060	-0.027*	-1.864	0.062	-0.015*	-1.858	0.063
$\Delta\ln REM^{+}$	0.054*	1.702	0.089	0.062*	1.795	0.073	0.058*	1.751	0.080
$\Delta\ln REM^{-}$	-0.024**	-2.003	0.045	-0.028**	-2.002	0.046	-0.025**	-2.270	0.023
ΔlnFDI	0.033*	1.661	0.097	0.037**	2.067	0.039	0.031*	1.725	0.085
ΔlnFD	0.028*	1.871	0.061	0.032*	1.682	0.093	0.026*	1.734	0.083
ECT(-1)	-0.032***	-3.002	0.003	-0.031***	-2.631	0.009	-0.058***	-2.642	0.008
Constant	0.283***	2.621	0.009	0.255***	2.697	0.007	0.261***	2.748	0.006
Obs.	2992			2244			748		
N group	68			51			17		

Source: Author's own estimation using Stata 17.0.

*Note: The subscripts '+' and '–' represent positive and negative changes, respectively. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.*

The magnitude of the estimated coefficients also varies across income groups, suggesting that the importance of external financial resources differs according to countries' structural and development characteristics.

4.6.1. Asymmetric Effects of ODA

The long-run estimates provide strong evidence of an asymmetric relationship between ODA and real GDP per capita. For the full sample, the coefficient of $\ln ODA^{+}$ is positive and statistically significant at the 1% level (0.465; $p = 0.010$), whereas

$\ln ODA^{-}$ is negative and statistically significant at the 1% level (−0.178; $p = 0.008$). Thus, increases and decreases in ODA are associated with different long-run responses of real GDP per capita. The magnitude of the positive coefficient indicates a relatively strong association between increases in aid and higher real GDP per capita, while the negative coefficient on a signed negative partial sum implies higher predicted real GDP per capita as aid declines. This counterintuitive association does not support the proposed adverse effect of aid reductions. The income-group estimates provide further evidence of heterogeneity. In MICs, the coefficient of $\ln ODA^{+}$ is positive and significant at the 5% level (0.470; $p = 0.049$), while $\ln ODA^{-}$ is negative and significant at the 10% level (−0.212; $p = 0.089$). In LICs, the corresponding coefficients are 0.559 ($p < 0.001$) and −0.401 ($p = 0.047$), respectively. The larger coefficients in LICs indicate that their real GDP per capita is more strongly associated with changes in ODA, particularly negative changes. This pattern is consistent with the greater relative importance of external development finance in economies where domestic fiscal capacity, financial depth, and alternative sources of external financing may be more limited. Several economic mechanisms may account for this relationship. ODA can support public investment, infrastructure development, human capital accumulation, health and education expenditure, and institutional capacity. Conversely, reductions in aid may constrain public expenditure and investment when recipient countries have limited domestic resources or struggle to replace external financing with alternative sources. These mechanisms provide plausible explanations for the estimated associations, although the present estimates should not be interpreted as directly identifying causal transmission channels.

The findings are broadly consistent with previous studies reporting positive long-run relationships between foreign aid and economic growth, including Gomanee et al. (2005), Karras (2006), Asteriou (2009), Bhattarai (2009), Nwaogu and Ryan (2015), Pradhan and Arvin (2015), Majumder and Donghui (2016), Cai et al. (2018), Kim and Lekhe (2019), Sethi, Bhujabal, Das, and Sucharita (2019), Van Dan and Binh (2019), Younsi, Bechtini, and Khemili (2021), Wehncke, Marozva, and Makoni (2023), Ofori et al. (2024), and Legass and Akkas (2025). The results nevertheless differ from studies such as Alvi, Mukherjee, and Shukralla (2008), Ang (2010), Herzer and Morrissey (2013), Sothan (2018), Yahyaoui and Bouchoucha (2021), Doerr (2025), and Vaswani and Padmaja (2026), which do not report comparable positive aid–growth relationships. An important contribution of the present analysis is therefore to show that the aid–growth relationship is not adequately represented by a single symmetric coefficient.

The short-run estimates are also asymmetric, although the magnitudes are considerably smaller than the long-run coefficients. Positive changes in ODA have positive and statistically significant coefficients in the full sample (0.050; $p = 0.055$), MICs (0.046; $p = 0.070$), and LICs (0.055; $p = 0.045$). Negative changes in ODA have negative and statistically significant coefficients at the 10% level in all three samples. These results indicate that the short-run response to ODA depends on the direction of the change. The relatively larger coefficient of positive ODA changes in LICs suggests that increases in aid may have a somewhat stronger short-run association with real GDP per capita in this group. Because $\ln ODA^{-}$ and $\Delta \ln ODA^{-}$ are negative partial sums, their coefficients should not be interpreted in the same manner as an ordinary variable measured on a positive scale. Instead, the coefficients capture the response of real GDP per capita to cumulative negative changes in ODA. The opposite signs of the positive and negative partial-sum coefficients provide evidence of asymmetric responses, while the smaller short-run coefficients relative to the long-run estimates suggest that ODA's growth-related effects may accumulate over time. Overall, the results support Hypotheses 1 and 3 on asymmetric ODA effects in both the short and long run. However, the long-run relationship is more pronounced and economically larger than the short-run relationship, particularly in LICs. This finding suggests that the growth implications of aid may depend not only on its direction of change but also on the persistence of those changes over time.

4.6.2. Asymmetric Effects of REM

The results for remittances reveal a similarly pronounced asymmetric pattern. In the long-run, lnREM+ is positive and statistically significant in the full sample (0.331; $p = 0.007$), MICs (0.342; $p = 0.047$), and LICs (0.328; $p = 0.009$). These estimates indicate that increases in REM inflows are associated with higher real GDP per capita across all three samples. The relatively similar coefficients across income groups suggest that the positive association between REM growth and economic growth is not confined to a particular income group. The coefficients of $\ln REM^{-}$ are negative and statistically significant in all three samples. As the negative partial sum becomes more negative when remittances decline, its reported negative coefficient implies higher predicted real GDP per capita. This counterintuitive association differs from the proposed adverse effect of remittance reductions. Evidence of asymmetry depends on the reported Wald test, rather than the signs of the two coefficients alone. Several channels may explain the positive association between remittances and economic growth. Remittance inflows can increase household disposable resources, support consumption and savings, finance education and healthcare, facilitate housing investment, and provide foreign-exchange resources. In some economies, remittances may also relax household liquidity constraints and facilitate small-scale investment. Conversely, declines in remittance inflows may reduce household purchasing power and investment capacity. These mechanisms are plausible interpretations of the empirical results but should not be regarded as directly identified causal channels.

The findings are broadly consistent with studies reporting positive remittance–growth relationships, including Karagöz (2009), Buch and Kuckulenz (2010), Fayissa and Nsiah (2010), Kratou and Gazdar (2015), Oshota and Badejo (2015), Quartey and Adamba (2015), Adams and Klobodu (2016), Meyer and Shera (2017), Zghidi, Sghaier, and Abida (2018), Olayungbo and Quadri (2019), Ben Mim and Ben Ali (2021), Odugbesan et al. (2021), Garcia-Fuentes et al. (2025), and Hamdaoui et al. (2026). However, the results differ from those of Glytsos (2005), Senbeta (2013), Pradhan (2016), Odugbesan and Rjoub (2019), Sutradhar (2020), and Islam (2024). The differences across studies may reflect variations in country coverage, sample periods, model specifications, and estimation methodologies. The short-run estimates reinforce this asymmetric pattern. The coefficient of $\Delta \ln REM^{+}$ is positive and statistically significant at the 10% level in the full sample (0.054; $p = 0.089$), MICs (0.062; $p = 0.073$), and LICs (0.058; $p = 0.080$). In contrast, $\Delta \ln REM^{-}$ is negative and statistically significant at the 5% level across all three samples: −0.024 (p = 0.045) for the full sample, −0.028 ($p = 0.046$) for MICs, and −0.025 ($p = 0.023$) for LICs. Thus, the estimated short-run response differs according to whether REM inflows increase or decrease. Compared with ODA, remittances display relatively consistent short-run effects across the income groups, which may reflect their direct transmission to household income and expenditure. Overall, the evidence supports asymmetric REM effects in both the short and long run. Under the signed partial-sum definition, the reported coefficients instead imply a positive predicted response

to remittance declines, so these estimates do not support the proposed mechanism. The relatively stable coefficients across income groups further suggest that remittances constitute an important external financial resource for both middle- and low-income developing economies. Taken together, the results support Hypotheses 2 and 4 in both the short and long run.

The control variables also exhibit economically meaningful relationships with real GDP per capita. lnFDI has a positive and statistically significant long-run coefficient in the full sample (0.548; $p = 0.030$), MICs (0.591; $p = 0.048$), and LICs (0.485; $p = 0.047$). Thus, higher FDI is associated with higher real GDP per capita in all three samples. In the short run, ΔlnFDI is also positive and statistically significant at the 10% level in the full sample (0.033; $p = 0.097$) and LICs (0.031; p = 0.085), and at the 5% level in MICs (0.037; $p = 0.039$). These results are consistent with Shahbaz and Rahman (2010), Tiwari (2011), Nkoa (2014), Hussain and Haque (2016), Zekarias (2016), Sothan (2018), Dinh, Vo, The, and Nguyen (2019), Younsi et al. (2021), and Wehncke et al. (2023), but contrast with Herzer (2012), who reported a negative relationship between FDI and economic growth in developing countries. Similarly, lnFD is positively associated with real GDP per capita in both the long-and short-run. The long-run coefficients are 0.527 for the full sample, 0.562 for MICs, and 0.541 for LICs, all statistically significant at the 5% level. The corresponding short-run coefficients are 0.028, 0.032, and 0.026, respectively, and are statistically significant at the 10% level. These findings are consistent with the broader finance–growth literature, including Zhang et al. (2012), Bist (2018), Qamruzzaman and Jianguo (2018), Ibrahim and Alagidede (2020), Younsi and Bechtini (2020), and Odugbesan et al. (2021), which generally link greater financial development to enhanced savings mobilization, improved access to credit, increased investment, and more efficient allocation of financial resources. ECT(−1) is negative and statistically significant at the 1% level in all specifications, confirming a stable long-run equilibrium relationship among the variables. The estimated adjustment coefficients indicate that deviations from the long-run equilibrium are corrected over time following short-run changes in lnODA, lnREM, lnFDI, and lnFD.

4.6.3. Asymmetric Responses during Economic Expansion

Tables 9 and 10 extend the analysis by examining whether asymmetric relationships vary by the state of economic activity. The positive partial sum of changes in real GDP per capita, $\Delta lnGDPpc^{+}$, captures periods of economic expansion, whereas the negative partial sum, $\Delta lnGDPpc^{-}$, captures periods of economic contraction. This distinction is important because the two measures represent different phases of economic activity and therefore require distinct interpretations of the estimated asymmetric effects. Table 9 shows that long-run economic expansion responds asymmetrically to both ODA and REM. The coefficient of $lnODA^{+}$ is positive and statistically significant in the full sample (0.072), MICs (0.066), and LICs (0.095), whereas $lnODA^{-}$ is negative and statistically significant across all three samples, with coefficients of −0.053, −0.050, and −0.071, respectively. These results indicate that increases in ODA are positively associated with economic expansion, whereas the negative coefficient on the signed decline component implies stronger expansion as aid declines. This result runs counter to the proposed adverse effect of aid reductions. The larger absolute coefficient for LICs suggests that economic expansion in this group is more sensitive to changes in ODA than in the full sample and MICs.

A similar pattern is observed for remittances. The coefficients of $lnREM^{+}$ are positive and statistically significant in the full sample (0.069), MICs (0.078), and LICs (0.067), whereas $lnREM^{-}$ has negative coefficients of −0.044, −0.039, and −0.058. These results indicate that increases in remittances are associated with stronger economic expansion, while the negative coefficient on the signed decline component implies stronger expansion as remittances fall. This result runs counter to the proposed adverse effect of remittance reductions. The larger absolute coefficient for $lnREM^{-}$ in LICs suggests greater sensitivity to negative REM changes in this group. The long-run coefficients of lnFDI and lnFD are also positive and statistically significant across all three samples, indicating that both variables are positively associated with economic expansion. These findings are consistent with the view that foreign investment and domestic financial development may support investment, capital accumulation, and more efficient resource allocation during periods of economic expansion.

Table 9. Long-run and short-run CS-NARDL estimates during economic expansion.

	Full sample		MICs		LICs	
Variables	**$\Delta lnGDPpc^{+}$**	**$\Delta lnGDPpc^{+}$**	**$\Delta lnGDPpc^{+}$**	**$\Delta lnGDPpc^{+}$**	**$\Delta lnGDPpc^{+}$**	**$\Delta lnGDPpc^{+}$**
Long-run estimates						
$lnODA^{+}$	0.072***		0.066***		0.095***	
	(0.006)		(0.004)		(0.006)	
$lnODA^{-}$		-0.053***		-0.050***		-0.071***
		(0.002)		(0.002)		(0.003)
$lnREM^{+}$	0.069***		0.078***		0.067***	
	(0.005)		(0.003)		(0.005)	
$lnREM^{-}$		-0.044***		-0.039***		-0.058***
		(0.003)		(0.005)		(0.002)
lnFDI	0.083***		0.091***		0.076***	
	(0.002)		(0.003)		(0.003)	
lnFD	0.074***		0.085***		0.080***	
	(0.003)		(0.003)		(0.004)	
Short-run estimates						
$\Delta lnODA^{+}$	0.003*		0.010*		0.023*	
	(0.068)		(0.066)		(0.062)	
$\Delta lnODA^{-}$		-0.014*		-0.021*		-0.010*
		(0.061)		(0.058)		(0.072)
$\Delta lnREM^{+}$	0.005*		0.012*		0.025*	
	(0.063)		(0.055)		(0.061)	

	Full sample		MICs		LICs	
Variables	**ΔlnGDPpc^{+}**	**ΔlnGDPpc^{+}**	**ΔlnGDPpc^{+}**	**ΔlnGDPpc^{+}**	**ΔlnGDPpc^{+}**	**ΔlnGDPpc^{+}**
ΔlnREM^{-}		-0.015*		-0.027*		-0.012*
		(0.071)		(0.065)		(0.058)
ΔlnFDI	0.032*		0.031*		0.038*	
	(0.060)		(0.065)		(0.070)	
ΔlnFD	0.018*		0.013*		0.015*	
	(0.067)		(0.061)		(0.054)	
ECT(-1)	-0.023***	-0.066***	-0.015***	-0.017***	-0.041***	-0.033***
	(0.003)	(0.005)	(0.002)	(0.004)	(0.003)	(0.002)
Constant	0.042***	-0.039***	0.031***	0.028***	0.045***	0.042***
	(0.005)	(0.004)	(0.005)	(0.003)	(0.003)	(0.002)
Obs.	2992	2992	2244	2244	748	748
N group	68	68	51	51	17	17

Source: Author's own estimation using Stata 17.0.

*Note: ΔlnGDPpc^{+} denotes the positive partial sum of changes in log real GDP per capita, representing periods of economic expansion. The superscripts (+) and (−) on lnODA and lnREM denote the cumulative positive and negative partial sums of changes in the respective explanatory variables. P-values are reported in parentheses. * and *** denote statistical significance at the 10% and 1% levels, respectively*

The short-run estimates broadly preserve the same signs as the long-run coefficients, although their magnitudes are considerably smaller. Positive changes in ODA and REM are positively associated with economic expansion, while the negative coefficients on signed decline components imply a larger expansion component when inflows fall. ΔlnFDI and ΔlnFD also exhibit positive short-run coefficients. The smaller short-run coefficients relative to the long-run estimates suggest that the associations between these financial flows and economic expansion are stronger in the long run than in the short run. The negative and statistically significant ECT(−1) coefficients across all specifications confirm adjustment toward the estimated long-run equilibrium relationship. Overall, the expansion-regime results provide evidence that the asymmetric relationships identified in the conventional CS-NARDL model persist when the analysis focuses specifically on the expansion component of GDP dynamics.

4.6.4. Asymmetric Responses during Economic Contraction

Table 10 reports the corresponding estimates for the contraction regime. Here, ΔlnGDPpc^{-} is constructed as the negative partial sum of changes in real GDP per capita. Consequently, more negative values indicate larger cumulative contractions. This feature is important for interpreting the coefficient signs, as a negative coefficient does not carry the same economic meaning as a negative coefficient in a conventional GDP growth regression. The long-run coefficient of lnODA^{+} is negative and statistically significant in the full sample (−0.038), MICs (−0.032), and LICs (−0.096). These estimates indicate that positive changes in ODA are significantly associated with greater economic contraction, with the larger absolute coefficient for LICs suggesting a stronger association in this group. In contrast, the coefficient of lnODA^{-} is positive and statistically significant across all three samples, with estimates of 0.003, 0.003, and 0.017, respectively. Because the negative ODA partial sum becomes increasingly negative as aid declines, a positive coefficient indicates that reductions in ODA are associated with a less negative value of ΔlnGDPpc^{-}. The substantially larger coefficient for LICs further suggests that ΔlnGDPpc^{-} is more sensitive to negative changes in ODA in this group. Remittances exhibit a comparable asymmetric pattern. The long-run coefficients of lnREM^{+} are negative and statistically significant in the full sample, MICs, and LICs, whereas the coefficients of lnREM^{-} are positive and statistically significant. Thus, positive and negative changes in REM are associated with statistically different responses in ΔlnGDPpc^{-}. However, because ΔlnGDPpc^{-} is constructed as a negative partial sum, these coefficients should not be interpreted mechanically as evidence that REM necessarily reduce or intensify economic downturns. Rather, they indicate that the contraction component responds differently depending on the direction of changes in REM.

Table 10. Long-run and short-run CS-NARDL estimates during economic contraction.

	Full sample		MICs		LICs	
Variables	**ΔlnGDPpc^{-}**	**ΔlnGDPpc^{-}**	**ΔlnGDPpc^{-}**	**ΔlnGDPpc^{-}**	**ΔlnGDPpc^{-}**	**ΔlnGDPpc^{-}**
Long-run estimates						
lnODA^{+}	-0.038***		-0.032***		-0.096***	
	(0.004)		(0.002)		(0.003)	
lnODA^{-}		0.003***		0.003**		0.017***
		(0.001)		(0.001)		(0.002)
lnREM^{+}	-0.030***		-0.028***		-0.024***	
	(0.005)		(0.003)		(0.003)	
lnREM^{-}		0.003***		0.004***		0.003***
		(0.001)		(0.001)		(0.001)
lnFDI	-0.054***		-0.058***		-0.047***	
	(0.006)		(0.002)		(0.005)	
lnFD	-0.045***		-0.052***		-0.048***	
	(0.003)		(0.003)		(0.002)	
Short-run estimates						
ΔlnODA^{+}	-0.017		-0.012*		-0.031	
	(0.112)		(0.067)		(0.124)	

	Full sample		MICs		LICs	
Variables	**ΔlnGDPpc⁻**	**ΔlnGDPpc⁻**	**ΔlnGDPpc⁻**	**ΔlnGDPpc⁻**	**ΔlnGDPpc⁻**	**ΔlnGDPpc⁻**
$\Delta lnODA^{-}$		-0.011**		-0.010**		-0.014
		(0.005)		(0.005)		(0.119)
$\Delta lnREM^{+}$	-0.022		-0.025*		-0.019	
	(0.114)		(0.070)		(0.152)	
$\Delta lnREM^{-}$		-0.009**		-0.012**		-0.015
		(0.034)		(0.036)		(0.110)
ΔlnFDI	-0.024*		-0.026*		-0.019*	
	(0.063)		(0.072)		(0.081)	
ΔlnFD	-0.020*		-0.022*		-0.016*	
	(0.059)		(0.061)		(0.065)	
ECT(-1)	-0.068***	-0.063***	-0.071***	-0.072***	-0.062***	-0.050***
	(0.002)	(0.004)	(0.002)	(0.005)	(0.003)	(0.004)
Constant	-0.024***	-0.035***	-0.022***	-0.033***	-0.016***	-0.029***
	(0.005)	(0.003)	(0.003)	(0.002)	(0.003)	(0.001)
Obs.	2992	2992	2244	2244	748	748
N group	68	68	51	51	17	17

Source: Author's own estimation using Stata 17.0.

*Note: $\Delta lnGDPpc^{-}$ denotes the negative partial sum of changes in log real GDP per capita, representing periods of economic contraction. The superscripts (+) and (−) on ODA and REM denote the cumulative positive and negative partial sums of changes in the respective explanatory variables. P-values are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.*

The coefficients of lnFDI and lnFD are also negative and statistically significant across all three samples. Because ΔlnGDPpc⁻ becomes more negative as cumulative contractions deepen, these estimates indicate that higher FDI and FD are associated with more negative values of ΔlnGDPpc⁻. These findings should therefore be interpreted cautiously and should not be taken as automatic evidence that FDI and FD stabilise economic activity during downturns. The short-run estimates are more heterogeneous across income groups. The coefficients of $\Delta lnODA^{+}$ are statistically significant only for MICs. The coefficients of $\Delta lnODA^{-}$ are negative and statistically significant for the full sample and MICs. Similarly, the coefficients of $\Delta lnREM^{+}$ are negative and statistically significant only for MICs, whereas the coefficients of $\Delta lnREM^{-}$ are negative and statistically significant in the full sample and MICs, but not in LICs.

These results indicate that short-run responses during contractionary periods are less uniform across income groups than the corresponding long-run relationships. The coefficients of ΔlnFDI and ΔlnFD are negative and statistically significant across all three samples. Since ΔlnGDPpc⁻ captures the negative component of changes in real GDP per capita, these coefficients should be interpreted as regime-specific associations rather than direct causal evidence that FDI or FD cushions or intensifies economic downturns. Finally, the ECT(−1) coefficients are negative and statistically significant in all contraction specifications, ranging from −0.050 to −0.072. This confirms convergence toward the long-run equilibrium following short-run deviations. The results therefore provide evidence of a stable long-run relationship even when GDP dynamics are decomposed according to contractionary periods. Taken together, Tables 9 and 10 demonstrate that the relationship between ODA, REM, and economic growth is state-dependent. The expansion specification provides clear evidence that positive external financial inflows are associated with stronger economic expansion, whereas the contraction specification reveals statistically significant but more complex responses because ΔlnGDPpc⁻ is defined as a negative partial sum. The regime-specific analysis therefore reinforces the importance of considering both the direction of external financial flows and the state of economic activity when examining the ODA–REM–growth nexus.

4.7. Robustness Checks: DCCE Estimation Results

The supplementary Dynamic Common Correlated Effects (DCCE) estimates in Table 11 show coefficient patterns similar to the CS-NARDL estimates. The long-run estimates display different coefficients for positive and negative ODA and REM components across the full sample, MICs, and LICs. Positive-change coefficients are positive, while the coefficients on signed negative partial sums are negative. Under the defined partial sums, the latter imply higher predicted real GDP per capita when inflows decrease. These results provide further evidence that increases and decreases in ODA and REM inflows have asymmetric effects on long-run economic growth. Similarly, FDI and FD exhibit positive and statistically significant long-run effects across all three samples. The positive coefficients indicate that greater FDI inflows and improvements in FD are associated with higher real GDP per capita. Although the magnitude and level of statistical significance vary somewhat across the income groups, the positive direction of the estimated effects remains consistent with the main CS-NARDL results. The short-run estimates also broadly support the main findings. In particular, ODA and REM display significant asymmetric effects across the samples. The reported short-run coefficients also differ by component. The negative coefficients on signed decline components imply higher, rather than lower, predicted real GDP per capita as inflows fall. This finding is consistent with the asymmetric short-run effects identified in the main analysis. In addition, FDI and FD exhibit positive and statistically significant short-run effects across the three samples, further supporting their contribution to economic growth.

Table 11. Robustness check: DCCE estimation results.

Variables	Full sample	MICs	LICs
Long-run estimates			
$lnODA^{+}$	0.349** (0.028)	0.298** (0.022)	0.357*** (0.007)
$lnODA^{-}$	-0.125** (0.032)	-0.148** (0.034)	-0.095** (0.031)

Variables	Full sample	MICs	LICs
$lnREM^{+}$	0.255*** (0.006)	0.285*** (0.009)	0.228** (0.022)
$lnREM^{-}$	-0.142** (0.020)	-0.107** (0.031)	-0.096** (0.019)
lnFDI	0.355** (0.033)	0.305** (0.027)	0.268* (0.053)
lnFD	0.361** (0.021)	0.358*** (0.009)	0.280** (0.026)
Short-run estimates			
$\Delta lnODA^{+}$	0.045* (0.055)	0.038* (0.058)	0.053** (0.025)
$\Delta lnODA^{-}$	-0.019* (0.060)	-0.023* (0.067)	-0.016** (0.030)
$\Delta lnREM^{+}$	0.019** (0.032)	0.027** (0.030)	0.023* (0.062)
$\Delta lnREM^{-}$	-0.024** (0.029)	-0.032** (0.021)	-0.027** (0.026)
ΔlnFDI	0.038* (0.063)	0.042* (0.060)	0.035* (0.062)
ΔlnFD	0.034* (0.061)	0.041* (0.054)	0.033* (0.057)
Obs.	2992	2244	748
N group	68	51	17

Source: Author's own estimation using Stata 17.0.

*Note: P-values are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.*

The DCCE estimates show coefficient patterns similar to the CS-NARDL results. They do not assess sensitivity to influential countries or the choice of transformation. The similarity of the reported estimates across approaches suggests that some coefficient patterns are not specific to the CS-NARDL estimator, although their substantive interpretation remains sensitive to the signed partial-sum definitions. Moreover, by accounting for cross-sectional dependence and slope heterogeneity, the DCCE approach provides additional evidence that the relationships identified between ODA, REM, FDI, and FD and real GDP per capita are broadly robust across country groups.

5. Conclusions and Policy Implications

This study examined the asymmetric effects of ODA and REM on real GDP per capita in 68 developing countries from 1980 to 2023 using the CS-NARDL framework. The reported coefficients differ between positive and negative changes in ODA and REM. Given the signed negative partial sums, their negative coefficients imply higher predicted real GDP per capita following decreases in these inflows, contrary to the proposed adverse mechanism. ODA effects are more pronounced in LICs, while REM effects are relatively stable across income groups. FDI and FD are also positively associated with real GDP per capita, highlighting the importance of complementary external and domestic financial conditions. The regime-specific results further show that these relationships depend on the state of economic activity, with statistically significant asymmetric responses during both expansion and contraction periods. However, contraction-regime coefficients require cautious interpretation because the dependent variable is defined as a negative partial sum. The DCCE estimates display similar coefficient patterns, although sensitivity to the choice of transformation and influential countries has not been assessed. Overall, the findings highlight the importance of considering both the direction of external financial flows and the state of economic activity when assessing their growth implications.

The findings have several policy implications. First, policies should focus not only on attracting external financial resources but also on strengthening domestic capacity to use them productively. For ODA, greater predictability, transparency, accountability, and alignment with development priorities are particularly important, especially in LICs where dependence on external development finance is relatively high. Second, reducing remittance transfer costs and expanding access to formal financial services can enhance the productive use of remittance income. Third, strengthening domestic financial systems can improve economies' capacity to mobilise savings, allocate credit, and absorb external financial resources. Finally, the asymmetric and state-dependent nature of the estimated relationships suggests that policymakers should distinguish between positive and negative external-finance shocks when designing macroeconomic and development policies. Maintaining adequate fiscal, financial, and external buffers may help countries respond more effectively to adverse changes in external financial inflows.

Despite these contributions, the study has several limitations. First, it does not formally assess the influence of outliers or individual countries, which may affect coefficient estimates given substantial cross-country variation in ODA and remittance flows. Future research could apply winsorization, robust estimators, and influential-country diagnostics. Second, the analysis identifies asymmetric associations but does not establish the specific causal mechanisms through which ODA and remittances affect economic growth. Future studies could examine the roles of institutional quality, aid dependence, financial development, governance, and sectoral structure. Third, further research could assess whether these asymmetries vary across alternative economic development classifications and across specific types of aid and remittance use. The reported results suggest that associations between external financial resources and real GDP per capita vary across income groups and the constructed outcome components; some signs run counter to the proposed mechanisms. The direction of changes in ODA and remittances matters, and the magnitude of their associations with real GDP per capita differs across income groups, economic regimes, and time horizons. These findings illustrate the value of examining increases and decreases separately, while the estimated associations alone do not identify causal policy effects.

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Appendix

Table A1. List of countries.

Middle Income Countries (MICs), *N* = 51			Lower Income Countries (LICs), *N*= 17
Algeria	Fiji	Morocco	Benin
Argentina	Gabon	Myanmar	Burkina Faso
Bangladesh	Ghana	Nicaragua	Burundi
Belize	Guatemala	Nigeria	Central African Republic
Bolivia	Guyana	Pakistan	Chad
Botswana	Honduras	Papua New Guinea	Congo, Dem. Rep.
Brazil	India	Paraguay	Guinea-Bissau
Cameroon	Indonesia	Peru	Haiti
Colombia	Iran	Philippines	Madagascar
Congo, Rep.	Iraq	Senegal	Malawi
Costa Rica	Jamaica	Sri Lanka	Mali
Cote d'Ivoire	Jordan	Sudan	Nepal
Dominican Republic	Kenya	Suriname	Niger
Ecuador	Lesotho	Thailand	Rwanda
Egypt, Arab Rep.	Malaysia	Tunisia	Sierra Leone
El Salvador	Mauritania	Turkey	The Gambia
Eswatini	Mexico	Zambia	Togo

Source: Author's creation.

Table A2. Variance Inflation Factor (VIF) results.

Variables	VIF	1/VIF
lnODA	2.76	0.362
lnREM	2.82	0.354
lnFDI	2.21	0.452
lnFD	3.46	0.289
Mean VIF	2.81	—

Source: Author's own estimation using Stata 17.0.

Table A3. Symmetry test results.

Null Hypothesis: Coefficient is symmetric					
		Long-run symmetry		Short-run symmetry	
		Statistic	Prob.	Statistic	Prob.
Full Sample	lnODA	50.144***	0.000	5.763***	0.000
	lnREM	55.128***	0.000	5.748***	0.000
MICs	lnODA	30.195***	0.000	4.864**	0.035
	lnREM	33.516***	0.000	4.635**	0.030
LICs	lnODA	17.954***	0.000	6.735**	0.033
	lnREM	20.842***	0.000	6.923**	0.028

Source: Author's own estimation using Stata 17.0.

*Note: ** and *** indicate rejection of the null hypothesis of symmetry at the 5% and 1% significance levels, respectively.*