

Foreign Aid, Trade, and Growth in MENA, Africa, and South Asia: An Analysis of Nonlinear and Conditional Effects

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Abstract

This study assesses whether foreign aid can foster sustained growth once regional heterogeneity and macro-structural conditions are accounted for. Using a dynamic panel of 41 developing countries across Africa, South Asia, and the Middle East and North Africa, we model real GDP per capita as a function of foreign aid, trade openness, gross fixed capital formation, infrastructure, and key macroeconomic controls, and estimate both non-linear and interactive effects within a System-GMM framework. The results indicate that trade integration and physical capital accumulation are consistently associated with higher income levels. By contrast, the effect of aid is conditional and non-linear: aid becomes growth-enhancing only once recipient economies reach a minimum level of absorptive capacity, after which marginal gains diminish. Moreover, a negative aid–trade interaction suggests that when aid is weakly aligned with productive and external-sector priorities, it can erode the income gains typically associated with openness. Infrastructure provision and price stability further strengthen the environment in which aid is most effective. Overall, the findings imply that aid is most likely to support sustained growth when coordinated with trade and investment strategies and targeted at constraints that raise absorptive capacity, particularly infrastructure and macroeconomic stability.

Keywords: foreign aid, trade openness, economic growth, absorptive capacity, developing economies, panel data

Article classification: Research paper

1 Introduction

Economic growth remains a cornerstone of national development agendas, widely regarded as a key indicator of macroeconomic health and policy effectiveness. It reflects an economy's ability to enhance living standards, generate employment opportunities, and foster social progress. However, achieving consistent and stable growth remains a challenge, particularly for developing economies. Unlike advanced nations, which often experience steady upward trajectories, developing countries frequently endure volatile boom-and-bust cycles. These cycles are typically driven by structural vulnerabilities, such as high public debt, inadequate infrastructure, and weak governance, coupled with temporary surges in aggregate demand (Atingi-Ego et al., 2021; Galor, 2005; Hang et al., 2010; Poghosyan, 2018).

The determinants of economic growth are categorised into supply-side, demand-side, efficiency-related, and institutional factors. Classical growth theories emphasise labour productivity, capital accumulation, and natural resource endowments as primary contributors (Ali & Bhuiyan, 2022; Asongu et al., 2024). More recent research, however, underscores the importance of trade openness, technological innovation, political stability, and human capital development in shaping long-term growth trajectories (Castellacci & Natera, 2016; Teixeira & Queirós, 2016).

Yet many developing countries struggle with systemic obstacles, including under-resourced education and health systems, limited infrastructure, political instability, and an overreliance on foreign aid (Bräutigam & Knack, 2004).

The concept of "sustainable economic growth" has gained prominence in recent literature, emphasising the need for growth that is not only robust but also resilient to shocks and policy disruptions. Sustainable growth favours productivity-led expansion over dependence on debt or aid. However, this form of growth remains elusive for many low-income countries in Asia and Africa. These economies often depend heavily on development aid to cover fiscal gaps and finance essential projects, raising the central question of this study: Is aid-led growth a viable and sustainable strategy, or does it perpetuate dependency and economic instability?

1.1 Regional Trends and Empirical Motivation

The regional growth patterns yield crucial insights into aid-led development dynamics, as illustrated in Figure 1. South Asia records the highest average GDP growth rate (5.35%), followed by MENA (4.22%) and Africa (3.96%). However, South Asia also exhibits the highest average aid dependency (20.94%), raising concerns about the structural soundness of its growth model. Africa exhibits the most pronounced volatility, with GDP growth ranging from -50.25% to 35.22%, reflecting its vulnerability to external shocks and internal governance challenges.

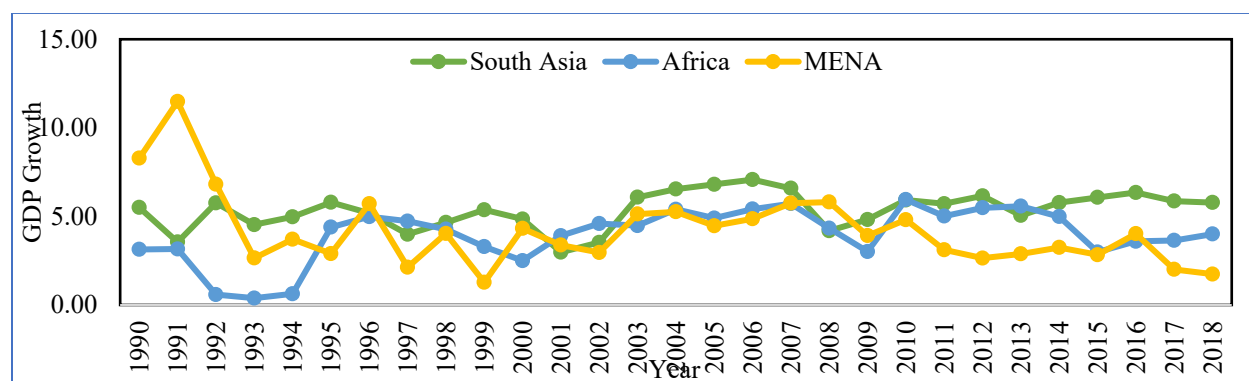


Figure 1: Regional Economic Growth Comparison

Source: Author's illustration.

The mixed performance of the MENA region further highlights the influence of political instability on economic outcomes. Trade openness varies markedly across these regions. The MENA region (mean TOP: 0.73) and Africa (0.64) exhibit moderate integration with global markets, whereas South Asia (0.35) remains relatively closed, limiting its trade-related growth opportunities, as shown in Table 1. The high aid-to-GDP ratios in South Asia and Africa exacerbate concerns about long-term sustainability if external assistance were to decline.

Table 1: GDP growth, Trade and AID, Regional Comparison

Region	Variable	Mean	Std. Dev.	Range	
				lower bond	upper bond
MENA ^a	GDP	4.22	4.90	-7.44	49.45
	TOP	0.73	0.28	0.12	1.50
	ODA	17.51	6.37	1.32	22.94
Africa ^b	GDP	3.96	5.04	-50.25	35.22

South Asia ^c	TOP	0.64	0.34	0.09	2.43
	ODA	19.85	1.17	15.57	23.15
	GDP	5.35	1.85	-1.55	9.14
	TOP	0.35	0.13	0.08	0.57
	ODA	20.94	0.70	19.11	22.05

Note: Detailed descriptive statistics and a list of selected countries are available in the Appendix.

a. *Selected Middle East and North American countries*

b. *Selected African countriesSelected South Asian countries*

An examination of regional growth patterns provides crucial insights into the dynamics of aid-led development. South Asia records the highest average GDP growth rate (5.35%), followed by MENA (4.22%) and Africa (3.96%). However, South Asia also exhibits the highest average aid dependency (20.94%), raising concerns about the structural soundness of its growth model. Africa displays the most pronounced volatility, with GDP growth ranging from -50.25% to 35.22%, reflecting its susceptibility to external shocks and internal governance challenges. The mixed performance of the MENA region further highlights the influence of political instability on economic outcomes. Trade openness varies markedly across these regions. The MENA region (mean TOP: 0.73) and Africa (0.64) exhibit moderate to high integration with global markets, whereas South Asia (0.35) remains relatively closed, limiting its trade-related growth opportunities. The high aid-to-GDP ratios in South Asia and Africa exacerbate concerns about long-term sustainability if external assistance were to decline. These disparities underscore the need for context-specific growth strategies that account for differences in trade integration, aid dependency, and domestic resource mobilisation. By empirically investigating these dimensions, this study provides critical insights into whether aid-driven growth models are sustainable and under what conditions they are most effective.

Despite a wealth of literature on the drivers of economic growth, two significant gaps remain. First, most existing studies fail to account for regional heterogeneity in evaluating the impact of foreign aid. There is a lack of comparative empirical research on how aid interacts with trade openness, capital formation, and macroeconomic stability across different regional contexts. Second, the interaction effects and potential non-linearities between aid and trade remain underexplored, particularly in aid-receiving countries. Many studies treat aid and trade as independent levers for growth, neglecting the possibility that one may reinforce or offset the other.

This study addresses these gaps through a comparative analysis of 41 countries across South Asia, Africa, the Middle East, and North Africa (MENA). Using a dynamic panel framework, the study examines the direct effects of foreign aid, trade openness, and capital formation on economic growth, as well as their interactions. Furthermore, it examines whether aid exhibits a non-linear relationship with growth, highlighting possible thresholds beyond which its benefits may diminish or even reverse. This comprehensive approach provides a nuanced understanding of how aid operates across diverse macroeconomic systems.

2 Review of Literature

A host of economic literature has examined economic growth and its dynamics. The studies have extensively analysed the role of many economic and non-economic factors in determining economic growth in both developed and developing economies. However, the studies mainly focused on the aid, trade, and growth nexus in Africa and Asia are largely considered.

Economic growth has been a central focus of research in development economics, with numerous studies examining the factors that contribute to a nation's long-term prosperity. Early models, such as the Solow-Swan model (Solow, 1956; Swan, 1956), suggest that economic growth results from the accumulation of physical capital, labour force growth, and technological advancements. However, it is widely acknowledged that other factors, including human capital, infrastructure, and governance, also play critical roles in determining growth outcomes (Barro, 1991; Mankiw et al., 1992). Over time, endogenous growth models emerged, emphasising the importance of technological innovation, human capital, and policies that foster investments in knowledge and infrastructure (Romer, 1990). More recent studies highlight the importance of institutions and political stability in shaping economic growth, emphasising that sustained growth is often contingent upon the quality of a country's institutions (Acemoglu et al., 2001; Halili & Rodriguez Gonzalez, 2025; Mensah, 2025).

In developing economies, the convergence hypothesis suggests that poorer countries should, in theory, grow faster than richer ones due to diminishing returns to capital in wealthier nations. (Barro & Sala-i-Martin, 1992). However, while the theory predicts convergence, empirical evidence has been mixed, with studies showing that countries may not always converge toward similar income levels due to structural differences, such as education, infrastructure, and institutional quality.

Furthermore, international trade has long been recognised as a crucial driver of economic growth. Classical trade theory, based on Ricardo's theory of comparative advantage (Ricardo, 2014), argues that countries benefit from specialising in producing goods with the lowest opportunity cost and trading with others. This leads to a more efficient allocation of resources, increasing overall productivity and wealth. Empirical studies have further corroborated the benefits of trade liberalisation and specialisation, which demonstrate that open trade policies promote faster economic growth. (Chen et al., 2022; Irwin, 2025; Kalai et al., 2024; Perla et al., 2021; Sachs & Warner, 1996). However, the relationship between trade and growth is not always linear, as trade openness may not lead to growth unless accompanied by complementary factors such as infrastructure development, education, and sound governance (Nasikhin et al., 2022). Furthermore, in today's interconnected global economy, the role of global value chains and services trade has gained increasing importance (Antràs & Chor, 2022; Blanchard et al., 2025).

The role of foreign aid in stimulating economic growth, particularly in developing countries, remains a central debate in development studies. Foreign aid, particularly from donor countries and international organisations, has been a key instrument for addressing poverty and supporting growth in low-income economies. Aid is often seen as a source to bridge financial gaps in developing countries, providing the capital needed for investments in health, education, and infrastructure. (Burnside & Dollar, 2000; Dreher et al., 2021). However, the effectiveness of foreign aid in promoting economic growth is a topic of considerable debate. Some scholars argue that foreign aid, if properly allocated, can indeed contribute to long-term development by financing essential public goods and supporting social and economic infrastructure. (Easterly & Levine, 2003). In particular, aid directed at sectors such as education, healthcare, and infrastructure is often found to impact growth positively (Collier & Dollar, 2002).

However, other studies highlight the limitations and challenges of aid effectiveness. The “dependency theory” suggests that foreign aid can lead to aid dependency, discouraging recipient countries from pursuing

sustainable growth strategies and instead focusing on short-term consumption (Cho, 2024; Kim, 2024). Aid may also be ineffective due to governance issues in recipient countries, such as corruption and poor institutional capacity (Alesina & Weder, 2002; Bräutigam & Knack, 2004, 2004; Iannantuoni, 2025). Moreover, some studies find that foreign aid may not lead to growth unless combined with policies that improve governance and foster structural reforms (Roodman, 2007).

Empirical evidence on the effectiveness of aid is mixed. On the one hand, studies have demonstrated that aid can contribute to growth in countries with effective governance and robust institutions. For example, Burnside and Dollar (2000) find that foreign aid effectively promotes growth when accompanied by sound fiscal and monetary policies. On the other hand, other research has suggested that foreign aid has little to no impact on growth in countries with weak institutions, high levels of corruption, and poor governance (Easterly, 2024). Furthermore, some scholars argue that aid might sometimes exacerbate problems of governance and inequality, especially when it is not properly targeted or flows into sectors with limited impact on long-term growth (Easterly & Levine, 2003).

The effectiveness of foreign aid is also influenced by its form and delivery. Studies show that bilateral aid (from one country to another) can be more politically motivated and may yield mixed results for growth and development. In contrast, multilateral aid, which is distributed by international organisations such as the World Bank and the IMF, tends to focus more on long-term developmental goals (Rahnama et al., 2017; Woods, 2000). Some evidence points to that aid conditionality, which requires recipient countries to implement specific economic reforms in exchange for aid, may be beneficial or detrimental. While it can prompt countries to enhance their economic governance, excessive conditionality can lead to policy mismatches and diminish the ownership of domestic reforms. (Fernández-Pasarín & Lanaia, 2025).

Further complicating the impact of aid is the potential for "aid fatigue," in which donor countries may become less willing to provide assistance due to economic downturns or shifting political priorities. As a result, the long-term sustainability of aid-driven growth remains uncertain, with scholars suggesting that aid should be seen as a complement to, rather than a substitute for, domestic policies focused on economic diversification and institutional development. (de Gaspi, 2024; Olander, 2019).

3 Theoretical and Conceptual Framework

Economic growth denotes the sustained expansion of a nation's output and income, conventionally measured through real Gross Domestic Product (GDP), Gross National Product (GNP), or per capita equivalents. These metrics map a country's development trajectory and serve as benchmarks for policy effectiveness. An intricate nexus of supply-side capacity, demand-side spending, and institutional quality propels growth. In developing economies, where boom-and-bust cycles are common, unpacking these interdependencies is critical to crafting effective interventions. By examining how aid inflows, trade integration, and capital formation interact with domestic institutions, this study offers nuanced, evidence-based insights to guide strategies for sustained and inclusive growth. Adopting this multidimensional lens moves the analysis beyond single-factor explanations and captures the systemic nature of development, thereby underscoring the study's relevance and urgency.

3.1 From Solow to Endogenous Growth

The Solow Growth Model (Solow, 1956) revolutionised growth theory by formalising how capital accumulation, labour expansion, and exogenous technological progress interact in a neoclassical production function. While capital deepening and labour inputs explain short-run movements, only technological progress sustains long-run growth, highlighting the pivotal role of investment in physical capital and innovation. Building on Solow's insight, endogenous growth theories, pioneered by Lucas (1988) and Romer (1990), internalise technological progress by contending that purposeful investments in education, research, and development, as well as human capital, can permanently raise growth rates. In this view, policy and institutional choices directly shape the innovation environment and, by extension, long-term prosperity.

3.2 Drivers of Growth

On the supply side, labour and human capital, captured by population growth and workforce quality, determine the effective supply of productive effort. Physical capital, proxied by gross fixed capital formation, complements labour and enhances its productivity, while technology and infrastructure, approximated by composite infrastructure indices and productivity metrics, facilitate the diffusion of innovation, reduce transaction costs, and expand the economy's productive frontier.

Demand-side forces revolve around the components of aggregate expenditure. Private consumption and private investment directly utilise an economy's productive capacity, whereas government final consumption expenditure (GFCE) can stabilise fluctuations, finance essential public goods, and crowd in private sector activity. Net exports and trade openness (TOP) widen market access, spur competition, and generate knowledge spillovers, reinforcing domestic productivity gains (Frankel & Romer, 1999). In developing economies, official development assistance (ODA) supplements domestic resources by financing capital projects, bridging fiscal gaps, and supporting institutional reforms (Burnside & Dollar, 2000).

Institutional quality, embodied in effective governance, secure property rights, and the rule of law (North, 1990), underpins efficient resource allocation. Macroeconomic stability, characterised by low and predictable inflation, stable interest and exchange rates, and prudent monetary expansion (as measured by the broad money supply, M2), bolsters investor confidence and reduces uncertainty. Financial development, steady remittance inflows, and political stability interact to create an environment that enables sustained growth.

3.3 Dynamic Panel Framework

To capture persistence and mitigate endogeneity, this study employs a dynamic panel model with lagged GDP per capita as an explanatory variable (Barro & Sala-i-Martin, 1992). The augmented specification integrates supply, demand, and institutional variables, enabling an assessment of how physical and human capital, trade openness, aid inflows, and macro institutions jointly shape growth in low and middle-income countries, as demonstrated in Figure 2.

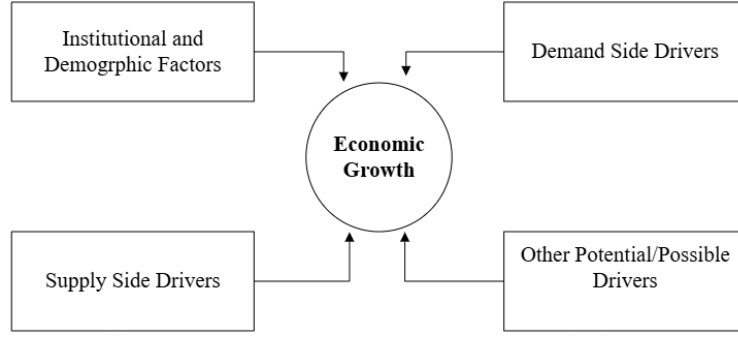


Figure 2: Nexus of Economic Growth and Determining Factors

The growth function and subsequent econometric model are given below. The generalised econometric model empirically determines and analyses the dynamics of economic growth over time and across cross-sections.

$$g = f(DSD, SSD, IDD, OPD) \quad (1-a)$$

$$g = \alpha + DSD\beta + SSD\gamma + IDD\delta + OPD\theta + \varepsilon \quad (1-b)$$

where g , the dependent variable, is economic growth traditionally measured by the growth in real GDP, DSD is a vector of demand side determining variables of economic growth, including consumption, investment/capital formation, government spending/expenditure, export, and import, vector SSD includes the supply side variables such as capital stock and/or share of capital, labour force and labour productivity, availability of natural resources, physical infrastructure, and total factor productivity, IDD is the vector containing the institutional and demographic related factors like political stability in terms of type of regime, control of corruption, rule of law, government effectiveness, regulatory quality, contract enforcement, ease of doing business indicators, trade openness, financial development (access to credit, population size and growth rate, dependency ratio, labor force participation rate, and human capital index (HCI) etc., vector OPD Contains other potential variables, especially non-conventional determinants, suggested by theoretical and empirical studies that cause economic growth, such as debt, aid, remittances, and macroeconomic uncertainty measured by the volatility/variance of key macroeconomic variables, including inflation and the real exchange rate. The ε is the random error term. The selection of variables depends on the nature of the problem, the issue at hand, relevance, data availability, and consideration of the degree of freedom.

4 Data and Methodology

This study adopts a theoretical framework that synthesises Solow and endogenous growth models to examine the dynamics of economic growth in developing countries. The analysis considers a range of supply- and demand-side variables within a dynamic panel-data framework, enabling an empirically robust investigation. In line with the recent literature (Armeanu et al., 2017; Guinet, 2003; Hussain et al., 2023). This study aims to identify the potential drivers of economic growth, focusing on the roles of development assistance and trade. In this perspective, the GDP is the dependent variable, while the other control variables include population, gross fixed capital formation, general government expenditure, infrastructure, inflation, and money supply.

$$GDPPC_{it} = \beta_1 GDPPC_{it-1} + \delta_1 X_{jt} + \varepsilon_{it} \quad (2)$$

in which: i, t are the country i at time t , respectively; $GDPPC$ is the proxy for economic growth; X is the vector of control variables including the investment (GFCF), the labor (POP), the inflation (INF), and the Infrastructure (INFINDEX), in this vector, j refers to j th variables in the vector; ε is the residual term; β and δ are the estimators. We use the following strategy to investigate the impact of aid and trade openness on economic growth. Firstly, we use trade openness (TOP) and aid (ODA) as a measure of economic growth, as explained in Equation (2):

$$GDPPC_{it} = \beta_1 GDPPC_{it-1} + \delta_1 X_{jt} + \alpha_1 ODA_{it} + \alpha_2 TOP_{it} + \mu_{it} \quad (3)$$

Secondly, we integrate the potential influence of government policies on economic growth as explained hereafter in Equation (3):

$$GDPPC_{it} = \beta_1 GDPPC_{it-1} + \delta_1 X_{jt} + \alpha_1 ODA_{it} + \alpha_2 TOP_{it} + \alpha_3 GFCE_{it} + \alpha_4 MS_{it} + \alpha_5 GFCF_{it} + \alpha_6 POP_{it} + \alpha_7 Infindex_{it} + \mu_{it} \quad (4)$$

where the GFCE proxy is used for the fiscal side, and MS serves as a proxy for the monetary side of economic stabilization policy. The details of the variables are presented in Table 2.

Table 2 Study Variables

	Definition	Source
GDPPC	Log of Real GDP per capita	WDI
ODA	Net official development assistance and official aid received	WDI
TOP	(Export + Import)/GDP	
MS	Broad money supply	WDI
GFCE	The general government's final real consumption expenditure	WDI
INF	Consumer price index	WDI
GFCF	Real gross fixed capital formation	WDI
POP	Population	WDI
Infindex	Infrastructure index using PCA by combining Air transport, Fixed telephone subscriptions, and Mobile cellular subscriptions (Table 3 & Figure 1 in Appendix A)	

4.1 Estimation Methodology

To address endogeneity concerns, particularly those arising from reverse causality, simultaneity, and omitted variable bias, this study employs the System Generalised Method of Moments (System-GMM) estimator, introduced by Arellano and Bover (1995) and further developed by Blundell and Bond (1998). The methodological strength of System-GMM lies in its ability to produce consistent estimates in dynamic panel models where explanatory variables, such as trade openness, government expenditure, and aid inflows, may be jointly determined with economic growth. This is particularly relevant for this study, which aims to investigate the conditional and interdependent effects of aid and trade on shaping growth outcomes.

System-GMM is not just a technical choice, but a necessary tool for isolating the response loops characteristic of development processes in low- and middle-income countries. Using lagged levels and first differences of

endogenous variables as internal instruments, the method addresses simultaneity and reverse causality in a way that static models cannot. Furthermore, including the lagged dependent variable (GDP per capita) among the regressors captures the inertia and persistence of growth paths, particularly salient in economies shaped by historical policy regimes and structural constraints. The method also overcomes weaknesses associated with conventional estimators by controlling for heteroskedasticity and serial correlation, issues that often undermine the reliability of results in macroeconomic panel data. Importantly, System-GMM simultaneously estimates both the level and the difference equations, thereby enhancing efficiency and addressing the weak-identification problem inherent in first-differenced GMM.

This study uses System-GMM to recognise that growth dynamics are inherently non-linear, path-dependent, and shaped by internal capacities and external shocks. Employing this estimator ensures that our findings on aid-led and trade-driven growth strategies are statistically sound and policy-relevant, offering credible insights into the conditions under which such strategies yield sustainable development.

5 Estimation, Results, and Discussion

5.1 Descriptive statistics

In this section, the estimation results for the selected panel are presented. The estimation results for the selected panel of countries begin with a summary of descriptive statistics that provides an overview of key economic indicators. Table 3 presents descriptive statistics for each variable, offering insights into the economic diversity among the countries analysed.

Table 3 Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
TOP	1111	-0.597	0.549	-2.45	0.889
ODA	1203	19.52	3.09	1.32	23.15
POP	1218	16.03	2.85	0.58	21.02
GFCF	1088	22.19	1.78	15.13	27.55
GFCE	1089	21.74	1.61	18.04	26.42
Infinindex	870	23.04	3.36	13.87	32.16
INF	1104	4.11	1.57	-21.60	6.79
MS	1089	18.23	2.42	14.37	42.51

Source: Authors' estimations.

The summary statistics reveal substantial variation across the dataset, underscoring the structural and macroeconomic diversity among the countries included in the analysis. GDPPC records a mean of 4.14, ranging from −50.25 to 49.45, indicating that while some countries experienced significant economic contraction, others achieved rapid growth. With a negative mean, TOP reflects limited trade integration in several economies. The mean value of ODA is 19.52, suggesting varying degrees of aid dependency across the sample. POP and GFCF show moderate variability, whereas GFCE appears relatively consistent across countries, indicating stable government spending patterns. INFINDEX exhibits a broad range, highlighting disparities in infrastructure development. INF fluctuates significantly, from deep deflation (−21.60) to moderate inflation (6.79), indicating macroeconomic volatility. MS also displays considerable dispersion, capturing the heterogeneity of monetary environments. These patterns highlight the

diverse economic conditions and institutional frameworks present in the panel. Such heterogeneity strengthens the case for applying the System-GMM estimator, which is well-suited to managing endogeneity and capturing the dynamic interactions inherent in cross-country growth relationships.

5.2 Empirical Results and Discussion

In this section, we estimate the empirical models outlined in Equation (3) using multiple estimation techniques, primarily focusing on the System Generalised Method of Moments (System-GMM) estimator. The objective is to determine whether foreign aid has a significant impact on economic growth in developing countries across Asia, Africa, and the Middle East. Our analytical approach builds on augmented Solow models, chosen for their capacity to explain variations in GDP per capita over time and across countries. These models incorporate the initial level of GDP per capita, gross fixed capital formation, and trade openness as key explanatory variables, emphasising the latter.

Error! Reference source not found. presents the regression results from pooled Ordinary Least Squares (OLS), fixed effects (FE), and System-GMM estimations. The reliability of the System-GMM estimator is rigorously tested through two diagnostic procedures. First, the Sargan and Hansen tests of overidentifying restrictions assess the validity of the instruments by ensuring they are uncorrelated with the error term. Second, the Arellano-Bond tests (Arellano & Bond, 1991) for AR (1) and AR(2) check for serial correlation in the residuals. As expected, AR(1) is present, while AR(2) is absent, confirming the model's appropriateness.

The coefficient on the lagged dependent variable (GDPPC(-1)) is positive and statistically significant at the 1% level across all models, supporting the hypothesis of conditional convergence. This suggests that lower-income countries grow more rapidly than wealthier ones, though they converge toward different income levels depending on structural conditions. This persistence in growth dynamics further justifies the use of a dynamic panel estimator such as System-GMM.

Trade openness (TOP) consistently exhibits a positive, statistically significant effect on economic growth, especially when macroeconomic controls such as government final consumption expenditure (GFCE) and the money supply (MS) are included, suggesting that trade-led growth is most effective when paired with prudent fiscal management and supportive financial systems. Rather than acting in isolation, trade openness is a conduit through which broader economic integration and productivity gains are realised. Despite its insignificance in the OLS model, gross fixed capital formation (GFCF) shows a strong, positive, and statistically significant relationship with GDP per capita in System-GMM estimations, highlighting the importance of properly addressing endogeneity to assess the impact of investment on growth. Similarly, the infrastructure index (INFINDEX) shows a consistent and positive association with growth across all model specifications, underscoring the foundational role of infrastructure in enabling economic activity, connectivity, and competitiveness.

Table 4: Empirical Estimates

Independent Variable	Dependent Variable: GDPPC							
	1 Pooled OLS	2 FE	3 S. GMM	4 S. GMM	5 S. GMM	6 S. GMM	7 S. GMM	8 S. GMM
GDPPC(-1)	0.986* (0.000)	0.932* (0.000)	0.993* (0.000)	0.936* (0.000)	0.933* (0.000)	0.958* (0.000)	0.926* (0.000)	0.944* (0.000)
TOP	0.010* (0.002)	0.013* (0.009)	0.004 (0.161)	0.088* (0.000)	0.087* (0.000)	0.053* (0.000)	0.074* (0.000)	0.064* (0.000)
GFCF	0.001 (0.486)	0.006* (0.140)	0.002** (0.010)	0.025* (0.000)	0.024** (0.013)	0.030* (0.003)	0.019** (0.040)	0.012** (0.002)
InfIndex	0.001** (0.027)	0.004* (0.000)	0.009*** (0.068)	0.010* (0.004)	0.010* (0.006)	0.004** (0.098)	0.013* (0.000)	0.002*** (0.071)
INF	-0.0002* (0.000)	-0.0002* (0.004)	-0.0009* (0.000)	-0.037* (0.001)	-0.034* (0.001)	-0.006 (0.590)	-0.034* (0.000)	-0.008*** (0.097)
ODA	-0.0005 (0.479)	0.0005* (0.775)		-0.006* (0.000)	-0.006* (0.000)	-0.003* (0.001)	0.018* (0.018)	0.008* (0.005)
GFCE					0.001 (0.834)	-0.026** (0.037)	0.004 (0.649)	0.010** (0.0.22)
MS						0.012 (0.324)		
ODA²							0.089** (0.026)	
ODA*Trade								-0.001* (0.000)
Observations	726	726	706	726	726	724	726	726
No. of Countries	41	41	41	41	41	41	41	41
R²	0.98	0.98						
No. of instruments			17	25	28	31	31	31
AR(2). P values ^a			0.800	0.847	0.849	0.908	0.840	0.919
Sargan/Hansen test ^b			0.138	0.126	0.181	0.128	0.142	0.122

Note: * and ** indicate significance at the 1% and 5% respectively. Figures also indicate the P-values.

a. The null hypothesis is that the errors in the first-difference regression exhibit no serial correlation.

The null hypothesis is that the instruments used are not correlated with the residuals. Inflation (INF) is found to have a consistently negative and statistically significant impact on growth, reaffirming the adverse consequences of macroeconomic instability. Volatile price levels can erode purchasing power, reduce investor confidence, and destabilise long-term planning, all of which are detrimental to sustained development. Foreign aid (ODA) exerts a more complex, conditional influence on economic growth. In the pooled OLS model, its coefficient is negative and statistically insignificant. However, System-GMM results present a more differentiated picture: ODA is negatively significant in Models 4-6 but becomes positively significant in Models 7 and 8. The significance of the quadratic aid term (ODA²) in Model 7 indicates a non-linear effect: aid may initially impede growth but become beneficial beyond a threshold. This reflects the critical role of absorptive capacity, in which aid can be used effectively only after meeting minimum governance or infrastructure benchmarks. The interaction term between aid and trade (ODA*Trade) in Model 8 is negative and statistically significant, indicating that the simultaneous presence of high aid and trade openness may not always yield synergistic outcomes. In some contexts, aid may even crowd out the productivity-enhancing effects of trade, particularly in the absence of institutional alignment or policy coherence. This finding adds nuance to policy discussions by challenging the assumption that aid and trade are universally complementary.

The validity of the System-GMM results is confirmed through standard diagnostic checks. The Hansen test for over-identifying restrictions supports the instruments' validity, while the Arellano-Bond AR(2) test indicates no evidence of second-order autocorrelation in the residuals. These outcomes affirm the robustness and credibility of the model specifications.

6 Conclusion

This study offers compelling evidence on the sustainability of aid-driven growth in developing economies across Asia and Africa. By empirically evaluating the relationships among foreign aid, trade openness, capital formation, and macroeconomic indicators, the analysis reveals that foreign aid alone is insufficient to drive economic growth. Its effectiveness hinges on supportive factors, including trade integration, infrastructure development, and macroeconomic stability.

Both trade openness and gross fixed capital formation consistently have a positive impact on growth, particularly when complemented by infrastructure investments and sound fiscal and monetary policy frameworks. Importantly, the relationship between aid and growth is non-linear; aid becomes a growth-enhancing factor only after a country surpasses a certain absorptive threshold. The significant negative interaction between aid and trade openness further suggests that the two may not always operate in tandem. Inflation remains a persistent constraint, undermining macroeconomic stability and long-term growth prospects.

These findings underscore the need for aid embedded within broader, context-specific development strategies that strengthen institutions, promote investment, and ensure stable macroeconomic environments. Sustainable aid-led growth requires a shift from uniform models to tailored, coordinated approaches between donors and recipients, aiming to achieve inclusive, resilient development outcomes.

6.1 Study Limitations and Future Research

While the study contributes valuable insights, it is not without limitations. Though suitable for cross-country analysis, macro-level panel data may overlook specific institutional dynamics and sector-level variations in aid effectiveness. Future research should incorporate disaggregated data and consider qualitative case studies to better capture the roles of governance quality, aid allocation mechanisms, and political stability. In addition, emerging dimensions such as environmental sustainability, digital infrastructure, and climate resilience should be explored to deepen our understanding of the evolving landscape of sustainable economic growth in developing regions.

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Declaration of competing interests

The authors declare no relevant financial or non-financial interests.

Data availability

The data and supporting materials used in this study are available for editorial and peer-review purposes. The shared materials include the raw/source data, cleaned analysis dataset, variable definitions, coding scheme, transformation notes, and statistical scripts used for data processing and empirical analysis. These files are available as supplementary materials accompanying the manuscript. Where the original raw data are obtained from publicly available third-party databases, the relevant source details are provided in the documentation, and the cleaned analytical dataset used in the study is supplied to enable verification of the reported results.

Ethics approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

Not applicable.

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