“Foreign direct investment, technology, and economic growth nexus in emerging markets”

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FOREIGN DIRECT INVESTMENT, TECHNOLOGY, AND ECONOMIC GROWTH NEXUS IN EMERGING MARKETS

Abstract

The study explored the impact of FDI on economic growth in emerging markets (Argentina, China, Colombia, Indonesia, Mexico, Peru, Republic of Korea, Turkey, Thailand, South Africa, Philippines, Malaysia, India, Czech Republic, and Brazil). Panel data ranging from 2007 to 2021 were used in this study. The impact of the interaction term (FDI x technology) on economic growth was also investigated using panel-corrected standard errors. The panel threshold approach was employed to examine the FDI threshold level that enables significant positive economic growth. Available literature shows that the nexus between FDI, technology, and economic growth remains a virgin academic and research area because existing empirical results are divergent, mixed, and quite conflicting. Panel-corrected standard errors show that FDI significantly reduces economic growth, whilst higher levels of FDI above the threshold level of 3.16 significantly enhance economic growth in emerging markets. Both econometric approaches employed noted that technology significantly improved economic growth, consistent with theoretical predictions. The conclusion is that higher levels of FDI and technology are of paramount importance in promoting economic growth. This economic grouping was selected because it experienced a rapid surge in FDI, economic growth, and technology in the last two decades, yet research on this topic remains very limited. Emerging markets are therefore encouraged to implement FDI and technology-enhancing policies to promote sustainable economic growth and development.

Keywords foreign direct investment, emerging markets, technology, economy, panel data, threshold

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INTRODUCTION

FDI improves the economic growth of a host country by bringing physical capital, technological advancements, technical know-how, and human capital development (Kobrin, 2005; Romer, 1993; Adedeji & Ahuru, 2016). Other theorists differed and pointed out that over-reliance on foreign capital creates some economic distortions in the long run. Consistent with Markusen and Venables (1999), FDI in the form of multinational firms leads to environmental degradation, social disruptions, profit repatriation, suppression of competition in the domestic market, and a lack of positive networks with local firms, causing a negative balance of payments. The superiority of foreign companies in terms of technology, physical capital, and technical know-how also deleteriously affects economic growth (Kumar, 1990). There is no consensus on the FDI-economic growth nexus from a theoretical standpoint.

What is coming out prominently from the empirical research is that the host country's characteristics, such as financial development, technological advancements, technology gap, and human capital development, are critical in ensuring that the economy benefits from FDI in-

flow (Li & Liu, 2005; Pelinescu, 2015). Few empirical studies have attempted to examine the interrelationship between FDI, technology, and economic growth. These empirical research works are characterised by some methodological deficiencies. They ignored the endogeneity problem normally prevalent in these kinds of models (Kusairi et al., 2023; Obeng-Amponsah & Owusu, 2025). Others made use of outdated datasets (Obeng-Amponsah & Owusu, 2025). None of them focused exclusively on emerging markets, itself a very important economic grouping characterised by rapid economic growth, financial development, and FDI inflows during the last two decades (Kusairi et al., 2023; Le et al., 2024; Asong & Odhiambo, 2020; Obeng-Amponsah & Owusu, 2025; Arbia & Sobhi, 2024). Others failed to appreciate that the complementarity between FDI and technology influences economic growth (Kusairi et al., 2023). This study fills in these gaps by investigating the (1) impact of FDI on economic growth, (2) influence of the complementarity variable (FDI x technology) on economic growth, and (3) threshold level of FDI necessary to enable significant economic growth in emerging markets.

1. LITERATURE REVIEW

According to Kobrin (2005), FDI produces a competitive space for local firms, generates employment, enhances human capital development, technological spill-overs, and participation in international foreign markets. FDI's major advantage to the host country, according to Romer (1993), is that it helps narrow the knowledge gap between developing and developed nations by harnessing new knowledge, skills, and technological spill-overs into the host nation. Consistent with Adedeji and Ahuru (2016), FDI contributes to economic growth by transferring financial capital, know-how, superior technology, skills, and good management practices to the host country. FDI is a huge source of external finance for low-income and emerging markets, creates employment, improves exports, transfers technology and skills into the host country as a way of contributing to economic growth (United Nations Conference on Trade and Development, UNCTAD, 2008).

In line with Ayenew (2022), FDI is not without its own drawbacks on the host country's economy. Firstly, Kumar (1990) argued that multinational firms' superiority in capital, technology, and managerial expertise over their local competitors may lead to crowding out domestic investment. Secondly, FDI may have a deleterious effect on the balance of payment position of the host country because of profits repatriation, negative impact on local environments (pollution), stifling of competition in the domestic market, social disruptions, and absence of positive linkages with domestic companies (Markusen & Venables, 1999). Theoretical literature ignored threshold effects in the FDI-growth nexus, did not consider the influence of channels as intermediaries between FDI and economic growth, and also totally ignored the endogeneity problem.

Over and above the theoretically linked controversies, extensive empirical research has been conducted on the impact of foreign direct investment on economic growth, with mixed results, as presented in the next few paragraphs.

Ayenew (2022) studied the impact of FDI on economic growth in Sub-Saharan Africa (SSA) using the autoregressive distributive lag (ARDL) and panel data stretching from 1988 to 2019. The short-run studies produced results that show an insignificant enhancing influence of FDI on economic growth, whilst the study observed that FDI had a significant positive impact on economic growth in the long run. Employing panel data (2008–2013) methods of analysis (random effects, pooled ordinary least squares, fixed effects), Adedeji and Ahuru (2016) explored the effect of FDI on economic growth in SSA countries. FDI was found to be a significant stimulant of economic growth in SSA countries. The nexus between FDI, technology, and economic growth was also explored from an empirical view. Asong and Odhiambo (2020) studied the interrelationship between FDI, information technology, and economic growth in Sub-Saharan African (SSA) nations using the GMM approach and panel data spanning from 1980 to 2014. They found that both internet and mobile phone penetration enhanced FDI's positive impact on economic growth in SSA. Empirical studies on SSA countries are characterized by

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methodological deficiencies such as failure to capture threshold effects, endogeneity, and interaction variable influence. The data used in their studies are generally now outdated.

Le et al. (2024) examined the inter-relationship between FDI, economic growth, and total factor productivity in middle-income countries using the system generalized methods of moments (GMM) with panel data spanning from 1990 to 2020. FDI had a significant positive influence on economic growth. Moreover, total factor productivity enhanced FDI's positive effect on economic growth. The same study also examined the nexus between total factor productivity, FDI, and economic growth in middle-income countries using the system GMM methodology with panel data (1990–2020). Total factor productivity, as represented by technological innovations, enabled FDI to significantly enhance economic growth in middle-income countries. Threshold effects did not feature at all, in contradiction to available literature.

Using the ARDL approach with time series data (1985–2019), Dagume et al. (2024) investigated the influence of FDI on economic growth in South Africa. In the long run, FDI was found to have a deleterious effect on economic growth in South Africa. A study by Tshepo (2014) examined the role of FDI in economic growth in South Africa using Granger causality tests with time series data (1990-2013). The study noted the existence of a long-run relationship between FDI, employment, and economic growth. The results showed that FDI had a significant enhancing effect on economic growth and that employment was positively influenced by FDI inflow. Matekenya and Moyo (2023) examined the linkage between economic growth, development, and foreign direct divestment in South Africa using the non-linear ARDL approach with time series data ranging from 1991 to 2019. Their study noted that the negative influence of foreign divestments on economic growth significantly outweighed the positive spill-overs brought in by FDI. Makhoba and Zungu (2021) used the vector autoregressive (VAR) approach with time series data (1960-2019) to examine the existence of a mutual relationship between FDI and economic growth in South Africa. Their study revealed the existence of a feedback relationship between FDI and economic growth in South Africa.

Masipa (2018) employed the VECM methodology with time series data (1980-2014) to investigate the relationship between FDI and economic growth in South Africa. In both the short and long run, a positive relationship between FDI and economic growth was observed, running from the former to the latter. Employing the ARDL approach with time series data (1980–2015), Bouchoucha and Ali (2019) studied the role of FDI in economic growth in Tunisia. In both the short and long run, FDI had a significant enhancing influence on economic growth in Tunisia. Alabi (2019) used multiple regression analysis and descriptive statistics to examine the impact of FDI on economic growth in Nigeria. Time series data (1986–2017) were used. The study concluded that FDI significantly enhanced economic growth, whilst the positive impact of domestic investment on the economy was non-significant. Husain (2024) examined the linkage between FDI and economic growth in Congo using a desk study methodology. The study observed that FDI encourages economic growth through its ability to bring technology, skills, managerial expertise, and physical capital into the host country. They also found out that absorption capacities, such as financial development, infrastructure, and institutional qualitative factors, enhance FDI's positive effect on the economy.

Employing GMM and two-stage least squares (2SLS) with panel data (1995–2021), Arbia and Sobhi (2024) also studied the relationship between information and communication technology, FDI, and economic growth in North Africa. The study noted that fixed telephone and internet penetration enhanced FDI's positive influence on economic growth in North Africa. Obeng-Amponsah and Owusu (2025) explored the interrelationship between employment generation, FDI, economic growth, and technological transfer in Ghana using autoregressive distributed lag (ARDL) with time series data (1995-2017). Technology has improved the influence of FDI's impact on economic growth in Ghana. Empirical studies on African nations are fraught with methodological weaknesses, such as failure to capture threshold effects, using outdated datasets, and ignoring the endogeneity problem normally prevalent in the FDI-growth relationships.

Boudiaf and Henniche (2023) studied the link between FDI and economic growth in the Arab region using panel ARDL methodology with data ranging from 1990 to 2000. No relationship between FDI and economic growth was noted in the short run. In the long run, the impact of FDI on economic growth was found to be very weak due to the absence of certain important conditions that attract foreign investments in the Arab region. Clearly, threshold effects were ignored, and the relationship between FDI and economic growth was wrongly assumed to follow a straight line.

Wang et al. (2022) explored the influence of FDI on economic growth using the bibliometric analysis approach in developing countries. The study noted that FDI significantly enhances economic growth, whilst the role of absorption capacities in influencing the FDI-economic growth nexus cannot be overemphasized. Using the GMM methodology and threshold regression analysis with panel data ranging from 1995 to 2019, Hai and Tuyet (2023) analyzed the impact of FDI on economic growth in developing countries. The study also examined the moderating influence of trade openness in the FDI-economic growth nexus. The results of the study indicated that FDI's positive influence on economic growth depended on the existence of the absorption capacity regarding trade openness at a level exceeding a threshold. Employing fully modified ordinary least squares (FMOLS) and vector error correction model (VECM), Dinh et al. (2019) explored the linkage between FDI and economic growth in developing countries. Their study observed that FDI negatively affected economic growth in the short run and stimulated economic growth in the long run. Developing nations' empirical studies did not consider threshold effects and the influence of interaction terms.

Employing dynamic panel ARDL methodology with annual data spanning from 1987 to 2018, Joo and Shawl (2023) examined the linkage between FDI and economic growth in BRICS countries. The study revealed the existence of a co-integrating relationship between FDI, economic growth, and several host country characteristics. The study noted that in countries characterized by low levels of human capital development, FDI had a negative influence on economic growth. Their results also showed that financial development had a significant positive impact on FDI's influence on economic growth. It focused on a portion of emerging markets, not in its entirety. Threshold effects were not considered, in contraction to an explanation by Li and Liu (2005).

Using Asia as a focal point of analysis, Jamshed et al. (2024) examined the link between FDI and economic growth. Their study employed random effects, pooled OLS, fixed effects, and two-system GMM with panel data ranging from 1995 to 2021. FDI's impact on economic growth was found to be positive and significant in Asia. In the context of Nepal, Dhungel and Lamichhane (2023) examined the impact of FDI on economic growth using the error correction model (ECM) with annual time series data (1995–2022). Their study observed that FDI encouraged economic growth in Nepal in the long and short run. They also noted that channeling remittances directly towards the productive sectors of the economy and controlling money supply enhanced FDI's positive impact on the economy. Melnyk et al. (2014) employed a fixed effects approach with panel data spanning from 1998 to 2010 to investigate the impact of FDI on economic growth in post communism transitional economies. Their study noted that FDI significantly contributed to economic growth. Institutional factors and financial development were found to be absorption capacities that influenced FDI's impact on economic growth. Empirical studies that focused on Asian nations clearly did not consider threshold effects, endogeneity, and interaction of variables as independent variables of the economic growth function.

Employing various panel data (2005–2022) analysis, such as GMM, fixed effects, pooled OLS, and random effects, Dang et al. (2023) studied the linkages between FDI, institutional quality, and economic development using the provinces of Vietnam as a focal point of analysis. Their study revealed that the complementarity between FDI and institutional quality enhanced economic growth in Vietnam. FDI as a stand-alone was found to have a positive effect on Vietnam's economy. Employing multi-regression analysis with annual time series data (1990–2013), Trinh and Nguyen (2015) explored the influence of FDI on economic growth in Vietnam. FDI had a significant enhancing effect on economic growth. Their study

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also noted that the complementarity between FDI and skills training improved economic growth in Vietnam. Zeng and Zhou (2021) explored the relationship between FDI, economic growth, pollution, and technological innovation in China's provinces using the dynamic panel simultaneous equation modelling (GMM). The Chinese panel data used ranged from 2004 to 2016. Their study noted that China's technological innovation and economic growth were positively influenced by the inflow of FDI. Empirical studies that focused on Asian countries did not consider the existence of threshold effects in the nexus between FDI and economic growth.

Employing a panel regression model with data ranging from 1998 to 2017, Okwu et al. (2020) examined the impact of FDI on economic growth in thirty leading global economies. Their study observed that FDI significantly enhanced economic growth-related activities. In Vietnam, as a focal point, Nguyen (2022) examined the FDI-economic growth linkages using the VAR approach. The time series data (1990-2020) was used. FDI was found to have exerted a positive influence on economic growth in the short run. However, FDI negatively affected economic growth in the long run. Using the G-20 countries as a unit of analysis, Almalik et al. (2024) explored the FDI-economic growth linkage. Their study employed the panel VECM methodology with data spanning from 2001 to 2022. A statistically significant and positive relationship running from FDI towards economic growth was observed in the context of G-20 countries. The moderating influence of government effectiveness was found to be irrelevant. Kusairi et al. (2023) examined the nexus between FDI, economic growth, and digitalization in developed countries using panel data (2006–2019) analysis. The study noted that both FDI and digitalization accelerated economic growth.

Using panel data (1970–1999) analysis, Li and Liu (2005) investigated the endogenous relationship between FDI and economic growth in both developing and developed countries. FDI was found to have had a direct and indirect positive influence on economic growth. The interaction between FDI and human capital development had a significant positive influence on economic growth. Moreover, the complementarity between FDI and the technological gap had a significant deleterious effect on economic growth. Baiashvili and Gattini (2019) investigated the influence of FDI on economic growth in high-income, middle-income, and low-income countries using a panel GMM approach with data beginning from 1980 to 2014. The study also explored institutional strength and income levels, as well as absorption capacities, which affected the FDI-economic growth nexus. The role of FDI in economic growth, considering the income level absorption capacity, was found to be U-shaped. Countries with better institutional quality experienced a high positive impact of FDI on economic growth. Methodological deficiency of these empirical studies is that threshold effects and endogeneity were totally ignored.

Empirical studies explored the influence of FDI on economic growth and produced results that fall into five categories. Consistent with Joo and Shawl (2023), some agreed that FDI enhances economic growth, whilst others agreed on the view that FDI's impact on economic growth is negative. The feedback view was supported by Makhoba and Zungu (2021), whilst the neutral hypothesis was supported by Boudiaf and Henniche (2023). The non-linearity view was also supported by some empirical studies, consistent with Trinh and Nguyen (2015) and Le et al. (2024). Such contradictions emanating from empirical literature is testimony that the relationship between FDI and economic growth is far from being a settled matter in the field of financial economics. The current study contributes to the literature by investigating the role of technology in the FDI-growth nexus and by estimating the FDI minimum threshold level above which it begins to significantly influence the economy.

The hypotheses of this study are as follows:

H1: There exists a threshold level of foreign direct investment that must be exceeded to enhance significant economic growth in emerging markets.

H2: There is a minimum threshold level above which FDI begins to trigger significant economic growth in emerging markets.

These hypotheses are aligned with Bick (2010). The literature review explains that FDI's effect on

economic growth occurs through channels in the host country, namely, financial development, human capital development, and technology, among others. The empirical results are also quite divergent, mixed, varied, and point to no consensus. Such observations in the existing literature review triggered the author's desire to carry out this study on the nexus between FDI, technology, and economic growth, using emerging markets as a unit of analysis.

2. METHOD

This study explored the impact of FDI on economic growth in emerging markets. Countries that fall into this category and were included in this study are Argentina, China, Colombia, Indonesia, Mexico, Peru, the Republic of Korea, Turkey, Thailand, South Africa, the Philippines, Malaysia, India, the Czech Republic, and Brazil. These countries fall into the emerging markets criteria produced by J.P. Morgan and MSCI. They were also included in the sample for this study due to data availability considerations. The panel data used range from 2007 to 2021. The period was chosen considering data availability and the desire to capture pre- and post-COVID periods. The data were extracted from World Development Indicators and the United Nations Development Programme (UNDP). Table 1 presents information on data sources, variables, and their proxies.

This study used panel-corrected standard errors (PCSE) and Hansen's (2000) panel threshold regression. PCSE is useful in addressing heteroscedasticity, autocorrelation, and cross-sectional dependency, which normally characterize panel data sets, whilst Hansen (2000)'s approach is useful for taking care of non-linear relationships and threshold levels in the FDI, economic growth, and technology nexus.

The empirical model posits that FDI and technology improve economic growth in emerging markets. The general model's specification for economic growth is as follows:

$$GROWTH_{it} = \alpha_0 + \alpha_1 FDI_{it} + Z_{it} + \mu_{it}, \quad (1)$$

$$GROWTH_{it} = \beta_0 + \beta_1 TECH_{it} + Z_{it} + \mu_{it}, \quad (2)$$

where $GROWTH_{it}$ stands for economic growth in country i at time t. Foreign direct investment (FDI_{it}) and technology ($TECH_{it}$) are key independent variables for this study. Z_{it} stands for a vector of control variables, namely human capital development, trade openness, population growth, financial development, tax revenue, and urbanization. The selection of control variables resonates with earlier empirical research such as Almalik et al. (2024), Trinh and Nguyen (2015), Nguyen (2022), Okwu et al (2020), Makhoba and Zungu (2021), Bouchoucha and Ali (2019), Zeng and Zhou (2021), and Dang et al. (2023).

Equation (3) captures the influence of the complementarity variable (FDI x TECH) on economic growth, consistent with earlier empirical studies (Li & Liu, 2005).

Table 1. Description of variables and source(s) of data

Source: Author.

Variable	Symbol	Proxy	Data source
Dependent variable			
Economic growth	GROWTH	GDP per capita	World Development Indicators
Independent variable			
Foreign direct investment	FDI	Net foreign direct investment (% of GDP)	World Development Indicators
Control variables			
Technology	TECH	Individuals using the internet (% of population)	World Development Indicators
Trade openness	OPEN	Exports of goods and services (% of GDP)	World Development Indicators
Human capital development	HCD	Human capital development index	United Nations Development Programme
Population growth	POP	Population growth (annual %)	World Development Indicators
Tax revenue	TR	Tax revenue (% of GDP)	World Development Indicators
Financial development	FIN	Domestic credit by the financial sector (% of GDP)	World Development Indicators
Urbanization	URBAN	Urban population (% of total population)	World Development Indicators

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$$GROWTH_{it} = \gamma_0 + \gamma_1 FDI_{it} + \gamma_2 TECH_{it} + \gamma_3 (FDI \cdot TECH)_{it} + Z_{it} + \mu_{it} \sum_{i=1}^{n} \left(X_i - \bar{X} \right)^2. \quad (3)$$

The model's partial derivatives with respect to FDI and technology are shown in equations (4) and (5). These derivatives help to quantify the influence of each variable on economic growth, consistent with Baltagi et al. (2009).

$$\frac{\delta GROWTH_{it}}{\delta FDI_{it}} = \gamma_1 + \gamma_3 TECH_{it}. \quad (4)$$

$$\frac{\delta GROWTH_{it}}{\delta TECH_{it}} = \gamma_1 + \gamma_3 FDI_{it}. \quad (5)$$

The PCSE method was adopted for estimating the models, as it corrects for heteroscedasticity, autocorrelation, and cross-sectional dependence, which are common statistical problems in panel datasets. The PCSE methodology employed in this study follows a two-step process. Firstly, converting data into natural logarithms to remove serial correlation. Secondly, followed by applying OLS with corrected standard errors.

Pesaran (2021)'s cross-sectional dependency test was performed before the models were estimated to deal with biased estimates. Lastly, Hansen (2000)'s threshold regression model was then applied to estimate the non-linear relationship between FDI and economic growth. The approach endogenously estimates the threshold above which FDI begins to significantly enhance economic growth. The modified Hansen (2000) threshold regression model is represented by equation (6).

$$GROWTH_{it} = \begin{cases} \beta_0^1 + \beta_1^1 FDI_{it} + \beta_2^1 X_{it} + \varepsilon_i, FDI_{it} \le \gamma \\ \beta_0^1 + \beta_1^2 FDI_{it} + \beta_2^2 X_{it} + \varepsilon_i, FDI_{it} > \gamma \end{cases}, \quad (6)$$

where FDI_{it} is the threshold variable whilst γ is the unknown threshold parameter. Hansen's (2000) model estimates nonlinearity between FDI and economic growth and shows whether FDI has a different influence on economic growth above or below the threshold level.

3. RESULTS AND DISCUSSION

Table 3 shows that the correlation between FDI and economic growth is positively weak (0.01), indicating that there are channels through which a significant influence of FDI on economic growth occurs. The results also show a significant positive correlation between (1) technology

Table 2. Theoretical explanation of control variables

Source: Author.

Variable	Theoretical explanation	Impact
Trade openness	Trade openness facilitates easy domestic and international trade, thereby increasing the chances of bringing into the country substantial amounts of foreign currency (Hart, 1983). The competition that comes from foreign enterprises may stifle domestic firms, which is not good for sustainable economic growth in the long run (Baltagi et al., 2009).	+/–
Human capital development	A developed human capital is essential for perpetuating economic growth through its ability to innovate and use technology advancements to smooth both domestic and international business (Pelinescu, 2015).	+
Population growth	According to Romer (1990), higher population growth leads to more technological progress because this increased number of people are also innovators and scientists. Simon (1989) argued that a larger population leads to increased demand of innovative goods and services, which then results in human capital endowment changes and higher productivity levels in the economy. On the contrary, Solow (1956) argued that higher population growth leads to low income per capita in the short term.	+/–
Tax revenue	Consistent with Ho et al (2023), increasing tax revenue collection gives the central government more room to allocate more funds towards consumption expenditure and investment, both critical for stimulating economic growth.	+
Urbanization	The high concentration of people in urban areas is good for the business and economy because it provides a big local market, enables access to finance, promotes innovation, and enhances external scale benefits (Glaeser et al., 2010). The migration of skilled people to urban areas enhances knowledge and skills spillovers and interactions, which is good for sustainable economic growth (Bacolod et al., 2010). Alam et al. (2007) argued that urbanization can lead to economic growth retardation through straining the infrastructure.	+/–
Financial development	Consistent with McKinnon (1973), the efficient allocation of financial resources in the economy is better performed by developed financial markets.	+

Table 3. Correlation analysis

Source: EViews.

	GROWTH	FDI	TECH	OPEN	HCD	POP	TR	FIN	URBAN
GROWTH	1.00								
FDI	0.01	1.00							
TECH	0.78***	–0.05	1.00						
OPEN	0.21***	–0.03	0.14**	1.00					
HCD	0.72***	0.09	0.58***	0.21***	1.00				
POP	–0.43***	–0.06	–0.39***	–0.19***	–0.42***	1.00			
TR	0.18***	–0.01	0.10	0.32***	0.02	0.18***	1.00		
FIN	0.25***	–0.21***	0.35***	0.46***	0.06	–0.34***	0.28***	1.00	
URBAN	0.76***	0.15**	0.60***	–0.18***	0.58***	–0.10	0.13**	–0.18***	1.00

Note: ***, **, and * stand for significance levels of 1 percent, 5 percent, and 10 percent, respectively.

and economic growth, (2) trade openness and economic growth, (3) human capital development and economic growth, (4) tax revenue and economic growth, (5) financial development and economic growth, and (6) urbanization and economic growth. Population growth and economic growth were also found to be negatively correlated in a significant way. Table 3 presents results for the correlation analysis.

These results are all supported by literature (see Table 2) and Section 2 of this paper. The existence of a multi-collinearity problem was observed in the correlation between technology and economic growth, human capital development and economic growth, and urbanization and economic growth, in line with Stead (1996). Table 4 shows descriptive statistics.

Table 4 shows that the range for trade openness and financial development exceeds 100, an indication that there exist extreme values in these two variables. The average for technology is 48.41% of the population, whilst its standard deviation is very high at 24.62. The average for trade openness is 47.27% of GDP, whilst its standard deviation sits at 31.49, which is also very high. The average for financial development is 71.64% of GDP, yet its standard deviation is a massive 45.95. Urbanization's average sits at 67.13% of the total population, whilst its standard deviation is very high at 16.79. These results indicate that there are extreme values in these variables.

Table 5 shows the results of PCSE (panel-corrected standard errors), both for the main effect and moderating influence of FDI and technology on economic growth. It is evident that the complementarity between FDI and technology significantly enhanced economic growth in model 2, in line with Baltagi et al. (2009).

Table 4. Descriptive statistics

Source: Author.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
GROWTH	240	3.84	0.33	2.91	4.55
FDI	240	2.55	1.44	0.01	9.66
TECH	240	48.41	24.62	2.81	97.60
OPEN	240	47.27	31.49	10.71	140.44
HCD	240	0.76	0.09	0.08	0.94
POP	240	1.02	0.46	0.01	1.97
TR	240	14.05	3.50	7.97	25.89
FIN	240	71.64	45.95	11.91	203.53
URBAN	240	67.13	16.79	29.57	92.23

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Table 5. Impact of the interaction between FDI and technology on economic growth

Variables	Model 1	Model 2
FDI	–0.01***	–0.06**
TECH	0.002***	0.0001***
FDI*TECH		0.0018***
OPEN	0.002***	0.002***
HCD	0.49	0.49
POP	–0.12**	–0.13**
TR	0.001***	0.0003***
FIN	0.001***	0.001***
URBAN	0.01***	0.01***
Constant	2.52*	2.61*
Observations	240	240
R-squared	0.86	0.87
Number of countries	15	15

Note: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 6 presents Hansen threshold estimation results. These results show the minimum threshold level of FDI (3.16) that enables significant economic growth in emerging markets.

Table 6. Threshold level of FDI that significantly influences economic growth

Number of Bootstrap replications	2000
Trimming percentage	0.15
Threshold estimate	3.16
LM-test for no threshold	31.61
Bootstrap p-value	0

Table 7 presents the results of threshold levels of FDI above which economic growth in emerging markets begins to occur. It is clear from the table that FDI inflows above 3.16% of GDP trigger significant positive economic growth.

The ensuing section comprehensively discusses and interprets the results of the threshold analysis.

The results presented in Table 5 show intricacies involving the influence of FDI and technology on economic growth in emerging markets. FDI had a significant negative influence on economic growth, in line with Kumar (1990), whose argument was that multinational firms' superiority in capital, technology, and managerial expertise over their local competitors may lead to crowding out domestic investment. Technology significantly enhanced economic growth in both models, consistent with Bernard and Jones (1996), whose study explained that technological advancements speed up the rate of economic convergence among different countries and economic groupings.

The interaction between FDI and technology significantly improved economic growth (see model 2 results). These results are in good agreement with Li and Liu (2005), who noted that the complementarity between FDI and technological gap negatively affected the economy in both developing and developed nations. Supported by literature in both models, control variables such as trade openness (Baltagi et al., 2009), tax revenue (Ho et al., 2023), financial development (McKinnon, 1973), and urbanization (Glaeser et al., 2010) had a significant positive influence on economic growth.

Table 7. Threshold results

Source: EViews.

Variables	Without threshold	Lower regime q ≤ = 3.16	Upper regime q > 3.16
FDI	–0.01***	–0.01***	0.03***
TECH	0.002***	0.001***	0.01***
OPEN	0.002***	0.002***	0.001***
HCD	0.49	0.37	1.05
POP	–0.12**	–0.07**	–0.15**
TR	0.001***	–0.004***	0.01***
FIN	0.001***	0.002***	0.009***
URBAN	0.01***	0.01***	0.01***
Constant	2.52	2.48*	2.41
Confidence interval		[3.13–3.28]	
Observations		240	
R–squared		0.86	
Number of countries		15	
Threshold value		3.16	

Note: ***, **, and * stand for significance levels of 1 percent, 5 percent, and 10 percent, respectively.

Population growth had a significant negative effect on economic growth in both models, in line with Solow (1956), who explained that higher population growth leads to low income per capita in the short term. Human capital development had a non-significant positive impact on economic growth, consistent with Pelinescu (2015), who noted that human capital development perpetuates economic growth through technological advancements, research, and innovation, which are key ingredients to succeed in international business ventures. The threshold diagnostic test shown in Table 6 highlights the intricacies of the non-linear dynamics in the relationship between FDI, technology, and economic growth in emerging markets. The threshold test was performed with 2,000 bootstrap replications and a 0.15 trimming ratio, which shows the existence of a significant threshold effect (3.16).

The threshold level of 3.16 is a minimum point above which FDI begins to significantly improve economic growth in emerging markets. LM-test for no threshold has a statistic of 31.61 and a 0 bootstrap probability value. Such a result significantly rejects the null hypothesis with no threshold, meaning there is a threshold effect in the relationship between FDI and economic growth. Reliability of the results was ensured using white-corrected errors. Tests for heteroskedasticity, model fitness tests, and endogeneity are presented in the appendix section.

The results shown in Table 7 show an FDI threshold level of 3.16, above which significant economic growth occurs. The threshold level of FDI, which is less than or equal to 3.16, had a significant negative (–0.01***) effect on economic growth. On the other hand, once the threshold level of FDI exceeds 3.16, FDI's impact becomes significant and positive (0.03***). These results support a theoretical argument put forward by Romer (1993), who suggests that higher FDI levels narrow the knowledge gap between developing and developed nations by a bigger margin.

Technology's influence on economic growth is significant and positive under both regimes, with the upper regime showing a stronger influence. The results resonate with the explanation of Bernard and Jones (1996) that higher levels of technological advancements speed up the rate of economic convergence among different countries and economic groupings. Trade openness significantly enhanced economic growth under both regimes, with the lower regime showing a stronger impact, consistent with Hart (1983), whose study argued that trade openness enhances economic growth through its ability to open the country to international commodity and financial markets. The results also support Baltagi et al. (2009), whose study noted that too much trade openness begins to retard economic growth.

Under both regimes, human capital development non-significantly enhanced economic growth. The positive influence is more pronounced under the upper regime, in support of a theoretical argument by Pelinescu (2015) that human capital development enables innovation, research, and accelerates technological advancements. Population growth had a significant negative influence on economic growth under both regimes, with the impact stronger under the lower regime. The results resonate with Romer (1990), who argues that higher population growth leads to more technological progress because a higher number of people increases the chances of producing scientists, researchers, and innovators. Tax revenue's impact on economic growth was found to be significantly negative under the lower regime, whilst the upper regime shows a significant positive relationship running from tax revenue towards economic growth. The results are in support of Ho et al. (2023)'s explanation that increased tax revenue collection affords the central government an opportunity to inject more financial resources into investment programs, which are key to economic growth.

Under both regimes, financial development's influence on economic growth was found to be positive and significant, with the upper regime showing a stronger impact. The results are consistent with McKinnon (1973)'s argument that more developed financial markets are better able to efficiently allocate resources for the betterment of the economy. The positive influence of urbanization on economic growth was the same (0.01***) under both regimes. The results support Bacolod et al. (2010)'s argument that increased skilled labor concentration in urban areas enhances economic growth through knowledge and skills spillovers.

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CONCLUSION

The study explored the impact of FDI on economic growth and the influence of the interaction term (FDI x technology) on economic growth in emerging markets. The study also examined the threshold level of FDI that enables significant positive economic growth in emerging markets. Panel-corrected standard errors show that FDI significantly reduces economic growth, whilst higher levels of FDI above the threshold level significantly enhance economic growth in emerging markets. Both econometric approaches employed noted that technology significantly improved economic growth, consistent with theoretical predictions. The conclusion is that higher levels of FDI and technology are of paramount importance in promoting economic growth in emerging markets. Emerging markets are therefore encouraged to implement FDI and technology-enhancing policies to promote sustainable economic growth and development. The limitation of this study is that (1) it exclusively focused on emerging markets and (2) it used a limited number of control variables. Further studies can use other relevant control variables and focus on regional analysis and not the macro country level.

AUTHOR CONTRIBUTIONS

Conceptualization: Kunofiwa Tsaurai.
Data curation: Kunofiwa Tsaurai.
Formal analysis: Kunofiwa Tsaurai.
Investigation: Kunofiwa Tsaurai.
Methodology: Kunofiwa Tsaurai.
Project administration: Kunofiwa Tsaurai.
Software: Kunofiwa Tsaurai.
Supervision: Kunofiwa Tsaurai.
Validation: Kunofiwa Tsaurai.
Visualization: Kunofiwa Tsaurai.
Writing – original draft: Kunofiwa Tsaurai.
Writing – review & editing: Kunofiwa Tsaurai.

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APPENDIX A

Diagnostic Test
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of growth
chi2(1) = 5.28
Prob > chi2 = 0.0215

Ramsey RESET test using powers of the fitted values of growth
Ho: Model has no omitted variables
F(3, 228) = 1.91
Prob>F = 0.1289

Table A1. Variance inflation factor

Variables	VIF	1/VIF
URBAN	3.001	0.333
TECH	2.75	0.364
HCD	2.3	0.435
FIN	2.143	0.467
OPEN	1.655	0.604
POP	1.64	0.61
TR	1.457	0.686
FDI	1.108	0.903
MEAN VIF	2.007	-

Test of endogeneity (orthogonality conditions)

Ho: Variables are exogenous
GMM C statistic chi2(1) = 1.59494 (p = 0.2066)

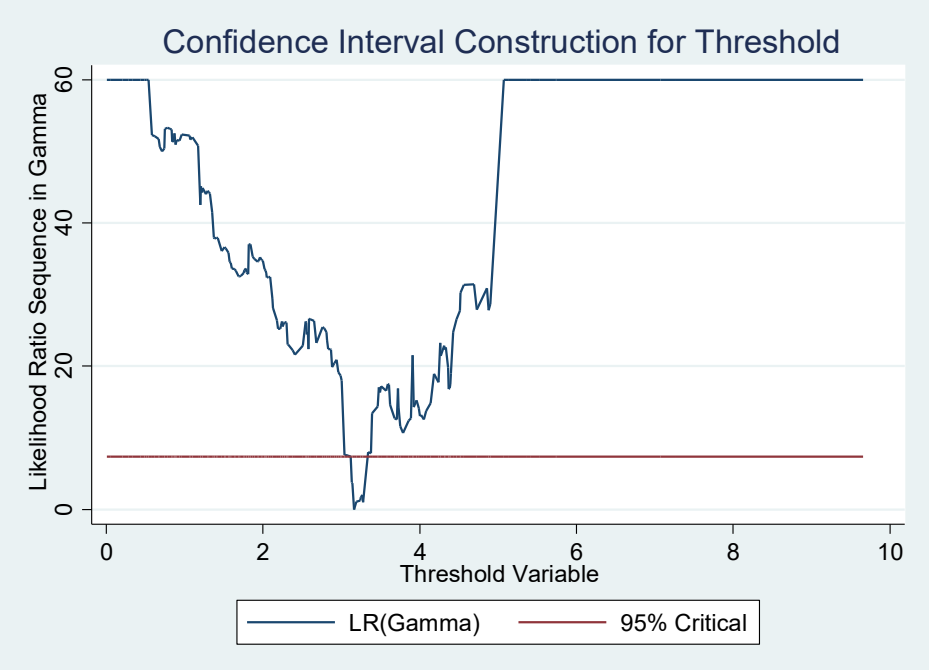

Figure A1. Confidence interval construction for threshold

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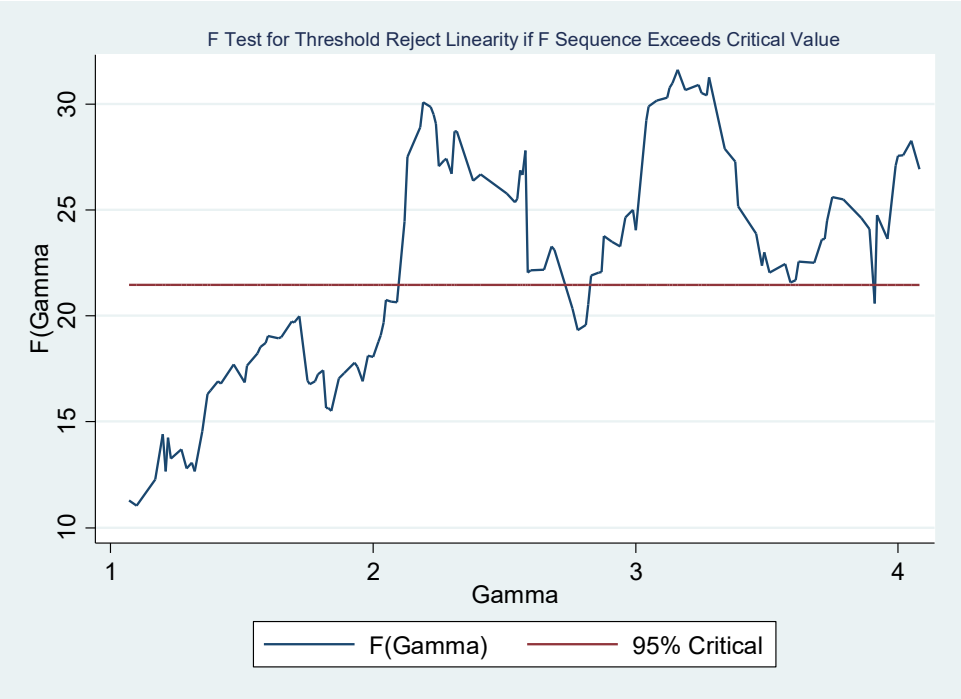

Figure A2. F-test for threshold reject linearity if F sequence exceeds critical value