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Investigating the Influence of Infrastructure Development on Poverty in Emerging Markets

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Abstract: The positive role of infrastructure development in the economy is well defined, exhausted and conclusive. It is the empirical studies on the influence of infrastructure development on poverty which is still mixed, contradictory, divergent and far from being exhausted. This study contributes to literature by exploring the impact of infrastructure development on poverty alleviation in emerging markets. It also studied the influence of human capital development in the infrastructure development-poverty reduction nexus. Specifically, whether human capital development is a channel through which poverty alleviation is influenced by infrastructure development in emerging markets. The study used fixed effects and the dynamic GMM approach with panel data from 1993 to 2021. Fixed effects show that infrastructure development significantly reduced poverty when infant mortality and life expectancy were used as proxies. On the contrary, the dynamic GMM approach noted that infrastructure development non-significantly decreased poverty using life expectancy and infant mortality rate as measures of poverty. Emerging markets should therefore implement infrastructure development enhancement policies to alleviate poverty. Fixed effects indicate that the interaction between infrastructure and human capital development significantly reduced poverty across all the three measures of poverty. The dynamic GMM however found out a non-significant poverty alleviating impact influenced by the interaction between infrastructure and human capital development (when infant mortality rate and life expectancy proxies of poverty are used). Emerging markets should implement joint human capital and infrastructure development policies to enhance poverty alleviation. The study also encourages future empirical research on exploring threshold levels of infrastructure development necessary to significantly improve poverty alleviation. It also encourages investigating human capital development threshold levels that helps infrastructure development to significantly alleviate poverty in emerging markets.

Keywords: Poverty; Human Capital; Infrastructure Development; Panel Data; Emerging Markets

JEL Classification: F24; J24; P2

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1. Introduction

1.1. Background of the Study

Poverty reduction has been at the center of global policy making in recent years (Alameddine, 2023). This is because countries have been trying to achieve the Millennium Development Goals (MDGs), of which one of them is the eradication of poverty, consistent with Adeyemi et al. (2009). Poverty alleviation is very important because it is associated with increased school enrolment, better access to health facilities, reduced drug abuse, more food access, access to better and quality education and generally less strife among the people, consistent with Bradshaw (2007). In line with Mdluli and Dunga (2018), to reduce poverty among the people, a proper understanding of the determinants of poverty is crucial so that relevant and effective poverty reduction policies can be implemented.

Infrastructure development is one of the most prominent determinants of poverty according to empirical research on the subject matter (Irawan et al., 2012; Ukwueze et al., 2019; Olusola & Aziegbemin, 2023; Nugrobo, 2015; Selepe et al., 2014; Mutiiria et al., 2020; Kaydor, 2023; Adu-Boahen et al., 2014; Desalegn and Solomon, 2022; Chen & Kuang, 2022; Abdul, 2002; Desalegn & Solomon, 2022; Husnah et al., 2023; Nkoa et al., 2022; Fagbemi et al., 2022). This study focused on the influence of infrastructure development on poverty in emerging markets. Although many empirical researchers focused on this subject matter (infrastructure development-led poverty reduction hypothesis), it is still clear that there is no consensus on the findings. They are still mixed, inconclusive and divergent. These empirical studies are now outdated and are no longer very useful for current policy making purposes on poverty. Majority of them failed to capture the vicious cycle of poverty in their studies. Surprisingly, none of these empirical studies on the influence of infrastructure development on poverty focused on emerging markets, an important global economic bloc. This research paper filled in these glaring gaps.

1.2. Contribution of the Paper

The study is unique in five different ways. Firstly, it is the first study to investigate infrastructure development's influence on poverty in the context of emerging markets, to the best knowledge of the author. Secondly, unlike previous empirical research on infrastructure development-poverty nexus whose data is now outdated for current decision-making policy making purposes, this study used the most recent data (1993-2021). Thirdly, this is the first study to investigate whether infrastructure development enhanced poverty alleviation through the human capital development channel in emerging markets, to the best of the author's knowledge. Fourthly, this study used the dynamic GMM approach to address the endogeneity problem of the poverty data, unlike previous similar studies which totally ignored it.

1.3. Organization of the Paper

Literature review is in Section 2, the effect of human capital development on poverty is in Section 3 whilst Section 4 presents the research methodology of the study. Section 5 is the correlation results and descriptive statistics. Section 6 presents result, discusses and interpret them. Section 7 summarizes the study whilst Section 8 summarizes the reference list.

2. Literature Review

Five theoretical rationales on the influence of infrastructure development on poverty exist. According to Jahan and McCleery (2005), a developed infrastructure reduces poverty through its ability to provide better market access, clean energy, health and quality education. Parker et al. (2008) argued that inadequate infrastructure through which services (clean water, education, health) are provided has got the effect of limiting the poor's engagement in meaningful economic activities aimed at reducing poverty among the people.

According to United Nations Human Development Programme (2015), the provision of services to the public through a developed infrastructural framework allows the disadvantaged poor community to focus more on important economic activities that contributes towards poverty alleviation. In other words, developed infrastructure then enhances the poor to focus more on poverty alleviation income generating projects. Ali and Pernia (2003) argued that irrigation, roads and electricity infrastructure development projects directly and indirectly influence non-agricultural and agricultural related activities which promotes income generating and employment opportunities for the poor. The same study argued that inadequate roads act as a barrier to the transportation of goods to and from these rural farming areas.

Zulu and Richardson (2013) noted that a highly developed infrastructure ensures that rural farmers do not spend most of their income on carrying products to and from the market. Banjo et al. (2012) explained that developed rural infrastructure accelerates productivity of the agricultural sector and growth hence alleviating poverty in the rural areas.

According to Zulu and Richardson (2013), social infrastructure development such as energy, health, education and communication infrastructure allows the people to actively participate in a variety of economic activities. Apart from lowering income inequality and raising economic growth, infrastructure development is a key ingredient in the poverty alleviation process (Calderon & Serven, 2004).

On the empirical front, many studies on the infrastructure development led poverty hypothesis have been done and produced divergent and mixed findings.

Mallek et al. (2024) examined the relationship between poverty and infrastructure development in sub-Saharan Africa using generalised methods of moments with panel data from 2003 to 2020. The results are very clear that infrastructure development in its various forms of indices alleviated poverty levels in African nations during the period under study. The study also revealed that infrastructure development in its composite form managed to reduce poverty via the employment, education and environment quality channels. Using the survey approach, Latif (2002) sought to establish the link between infrastructure development, income, poverty and consumption in Bangladesh. Multiple regression and bivariate analysis indicated that infrastructure development had a significant positive influence on consumption, income and poverty reduction in Bangladesh.

Seetanah et al. (2009) employed the dynamic GMM methodology and fixed effects with data ranging from 1980 to 2005 to examine the poverty alleviating impact of infrastructure development in developing nations. The results from both panel data research approaches show that urban poverty was indeed reduced by both communication and transport infrastructure. The study also confirmed theoretical rationales that poverty is a vicious cycle. Using structural vector autoregressive method with quarterly time series data from 1970 to 2005, Ogun (2010) examined the influence of infrastructure on poverty in Nigeria. The study observed that poverty reduction was enhanced by infrastructural

development. The results also show that social infrastructure contributed more towards poverty reduction than physical infrastructure in Nigeria urban areas. A survey done by Sawada (2015) supported the view that infrastructure development enhances in its variety of forms such as reducing employment, health hazards, poverty and income inequality, including enhancing education standards.

Using panel analysis methods with data from 2010 to 2016, Aderogba and Adegboye (2019) analysed how infrastructure development affected poverty in both rural and urban areas of Nigeria. The different indices show that poverty in both rural and urban areas was greatly alleviated by the developed infrastructure.

Using critical literature review analysis, Alameddine (2023) explored the linkage between poverty and infrastructure development in sub-Saharan Africa. A comparative regional approach was used to place Africa within the global scheme of things. The study showed that infrastructure development was quite key in sub-Saharan Africa’s economic development, including poverty alleviation, income inequality and unemployment reduction, among other economic development indices.

Empirical literature on the infrastructure development-led poverty reduction is summarised in Table 1.

Table 1. Empirical Literature Summary

Author	Unit of analysis	Timeframe	Methodology	Results
Achjar (2010)	Indonesia	2006 survey data	Probit model	Educating the head of the household and village improvements were found to have enhanced household poverty reduction efforts in Indonesia.
Jerome (2011)	Africa	1997-2009	Panel data analysis	Results which supports poverty reduction triggered by infrastructural development in Africa were observed.
Qin et al. (2022)	China’s 31 provinces	2002-2017	Panel data analysis	Drainage and irrigation infrastructural facilities led to poverty reduction. Transport infrastructure in the rural areas was found to have led to reduction in poverty through its economic growth enhancement effect.
Fagbemi et al. (2022)	Nigeria	1996-2019	Vector Error Correction Model and Granger causality tests	Both economic and social infrastructure had a poverty reduction influence in Nigeria. A bi-directional causality between poverty and infrastructural development in Nigeria was also observed. Investments in sustainable new infrastructure was found to key in addressing poverty alleviation not only in Nigeria but in developing nations as a whole.
Owusu-Manu et al. (2019)	Ghana	1980-2016	Autoregressive distributive lag (ARDL)	Infrastructural development -led economic growth and development was confirmed in the context of Ghana. Electricity generating ability had the greatest positive impact on economic growth and development in Ghana during the period under study.
Husnah et al. (2023)	Indonesia’s 34 provinces	2017-2020	Multiple regression analysis	Infrastructure development reduced poverty levels in all 34 provinces of Indonesia. Economic growth also played a

				mediating role in ensuring that poverty alleviation is positively influenced by infrastructure development.
Schachtebeck and Mbuya (2006)	Developing countries	Survey data	Critical literature review analysis	Poverty alleviation was enhanced by improved road infrastructure. Their study noted road infrastructure development reduced poverty directly and indirectly in developing nations.
Meilvidiri et al. (2020)	Indonesia	2010-2015	Multiple regression analysis	Energy infrastructure had a high level of positive influence on poverty reduction. Infrastructural development however had a positive effect on economic growth as expected. The impact of residential infrastructure such as clean water, health, education and improved communication network in eastern Indonesia was found to be more pronounced.
Nkoa et al. (2022)	Sub-Saharan Africa	2003-2020	System GMM approach	Extreme poverty was significantly reduced by development of infrastructure in Sub-Saharan Africa.
Rukema (2022)	South Africa	Critical literature review analysis	Interpretive approach of the existing literature	Insufficient infrastructure had very serious negative consequences on the well-being of the people especially those from previously disadvantaged population groups. Inadequate infrastructural development also acted as an impediment to social cohesion in the society in South Africa.
Abdul (2002)	Bangladesh	1995 and 2000 survey data	Multiple regression analysis	Trading networks and transport infrastructure positively affected consumption, income and poverty reduction in Bangladesh.
Desalegn and Solomon (2022)	Ethiopia	Survey data	Multiple regression analysis	Poverty reduction was enhanced by the development of both physical and social infrastructure in Ethiopia. The gross inequality in infrastructure investment among regions was found to be behind regional disparity in poverty levels.
Hartwig and Nguyen (2022)	Southeast Asia	2010, 2013 and 2016 household survey data	Panel multiple regression analysis	The ability to absorb shock among households was enhanced by the development of both information and communication technology and transport infrastructure.
Chen and Kuang (2022)	Asia	2000-2020	GMM methodology	Infrastructure development led poverty alleviation hypothesis was confirmed in the context of Asia. The study noted that it is way easier to withstand poverty in the rural areas of Asia if one has access to improved energy, health and water infrastructure. A feedback view was also observed between poverty and infrastructure development in Southeast Asia.

Kaydor (2023)	Liberia	1989-2003	Critical literature review analysis	The study noted that key infrastructural development such as water, energy, transport and communication was necessary to ensure sustainable economic growth, economic development and poverty reduction in Liberia.
Mutiara (2020)	Ace's districts	2015-2019	Panel data analysis	Improved electricity, road and hotel infrastructure greatly improved economic performance and poverty alleviation efforts during the period under study.
Adu-Boahen et al. (2014)	Ghana-Jukwa Central region	Survey data (2010-2013)	Descriptive statistical analysis	The existence of a huge infrastructural development gap within the Jukwa community contributed to majority of the socio-economic challenges faced in the community, include poverty, unemployment and inequality.
Selepe et al. (2014)	Ntambanana, KwaZulu-Natal in South Africa	Survey data	Descriptive statistical analysis	The study noted that small scale rural farmers' operations were crippled by poor road network and inefficient infrastructural development in general.
Mutiiria et al. (2020)	Sub-Saharan Africa	2003-2017	Panel data analysis	Developed infrastructure was found to have Granger caused inclusive growth among the people. Information and communication technology, transport and energy infrastructure led to inclusive growth and poverty alleviation. Poor people were found to have gained more than rich people from increased infrastructure development.
Nugrobo (2015)	Indonesia's 26 provinces	2000-2008	Panel data analysis	Education, health and electricity transmission infrastructure significantly enhanced poverty reduction through the human capital development channel. In other words, human capital development enabled infrastructural development to significantly reduce poverty in Indonesia.
Olusola and Aziqibemin (2023)	Nigeria	1986-2921	ARDL approach	Electricity, education, health, road and energy infrastructure all reduced poverty in Nigeria both in the short and long run.
Irawan et al. (2012)	Indonesia	Survey data	Descriptive statistics	Various forms of infrastructural development were found to have had a poverty reduction effect in Indonesia. Infrastructure development also reduced income inequality, increased government revenue, income levels and economic growth.
Ukwueze et al. (2019)	Sub-Saharan Africa	Time series annual data (2002-2016)	Panel data analysis (Fixed effects)	Social infrastructural development (infrastructure for curbing corruption) enhanced efforts to improve economic recovery and sustainable development.

Source: Author compilation

This section extensively discussed both theoretical and empirical literature on the influence of infrastructural development on poverty. It is quite clear that there is no consensus as to the influence of

infrastructure development on poverty even though majority of the literature supports the infrastructure development-led poverty alleviation hypothesis.

The literature on the infrastructure development's impact on poverty is divided into four groups. Firstly, the positive influence of infrastructure development on poverty reduction. Secondly, the bidirectional relationship between poverty and infrastructure development. Thirdly, a weak causality relationship between infrastructure development and poverty. Fourthly, the channel view, which argues infrastructure development indirectly enhances poverty reduction through various channels such as human capital development. The emergence of these four groups of literature shows an absence of consensus on the infrastructure development-poverty nexus literature. It also indicates that the literature on the subject matter is mixed, conflicting, divergent and far from reaching a consensus.

3. Effect of Human Capital Development on Poverty

According to Chaudhry and Rehman (2009), human capital development reduces poverty through its ability to empower people with education, skills and good health. Skilled and educated people have better chances of securing employment, earning high levels of income, save, invest and increasing their wealth, according to Afzal et al. (2010). A study by Mallek et al. (2024) observed that human capital development was a channel through which infrastructure development enhanced poverty reduction in Africa. An empirical study by Nugrobo (2015) also noted that education, electricity and health infrastructure had a poverty reduction influence through the human capital development channel in Indonesia.

4. Methodology

The study used secondary panel data ranging from 1993 to 2021 for emerging markets countries. This is the most recent data publicly available in reputable international databases such as World Bank, International Monetary Fund, African Development Bank and International Financial Statistics.

The general model specification of the poverty function is represented by equation 1 below.

$$\text{POVERTY} = f(\text{INFR}, \text{HCD}, \text{FDI}, \text{FIN}, \text{REMIT}, \text{GROWTH}, \text{SAV}) \quad [1]$$

Where POVERTY stands for poverty levels in emerging markets. INFR is infrastructural development, HCD represents human capital development whilst FDI is foreign direct investment. Financial development is represented by financial development, REMIT stands for personal remittances whilst economic growth is represented by GROWTH. Savings is represented by the abbreviation SAV.

The selection of the explanatory variables included in the model resonates with prior empirical research such as Ukwueze et al. (2019), Irawan et al. (2012), Nugrobo (2015), Olusola and Aziegbemin (2023), Mutiiria et al. (2020), Selepe et al. (2014), Adu-Boahen et al. (2014), Kaydor (2023), Chen and Kuang (2022), Desalegn and Solomon (2022), Desalegn and Solomon (2022), Abdul (2002), Nkoa et al. (2022), Husnah et al. (2023) and Fagbemi et al. (2022).

Explanatory variables' influence on the dependent variable (POVERTY) is theoretically explained in Table 2.

Table 2. Theoretical Rationales of the Explanatory Variables

Variable	Theoretical rationales	Expected influence
Savings	According to Steinert et al. (2017), savings leads to investment, which in turn brings in returns hence it is a sustainable way upon which poverty alleviation can be premised upon. Financial markets' investment return was argued to afford people a chance to increase their wealth if inflation is low.	-
Remittances	According to Anyanwu and Erhijakpor (2010) argued that in the long run, over reliance on personal remittances inflow increases poverty. Economic growth, education, health, entrepreneurship and self-employment and poverty alleviation are enhanced by the inflow of personal remittances (Cattaneo, 2005).	+/-
FDI	Literature argues that over relying on FDI inflows as a means of fighting poverty can backfire in the long run. The ability of FDI to improve liquidity, skills levels, innovation, job creation, human capital development and income levels helps to lower poverty levels, according to Romer (1986).	+/-
Economic growth	Economic growth is a locational advantage of FDI as it provides a conducive macroeconomic climate favoured by both domestic and international investors. The resultant increased employment levels help to improve people's income and wealth levels. (Dunning, 1988). Kuznets (1995) argued that poverty levels are still high at a low-level economic growth stage.	+/-
Financial development	According to Boukhaten (2016), a developed financial market increases poverty because it makes it very difficult for people to access small loans for self-help projects as the demands for collateral security increases. On the contrary, a developed financial market enables people to access loans at an affordable cost from a variety of financial institutions to carry out their income generating and wealth creation small projects (World Bank, 2001).	+/-

Source: Author

$$\begin{aligned}
 \text{POVERTY}_{it} = & \beta_0 + \beta_1 \text{INFR}_{it} + \beta_2 \text{HCD}_{it} + \beta_3 (\text{INFR}_{it} \cdot \text{HCD}_{it}) + \beta_4 \text{FDI}_{it} + \beta_5 \text{FIN}_{it} + \beta_6 \text{REMIT}_{it} \\
 & + \beta_7 \text{GROWTH}_{it} + \beta_8 \text{SAV}_{it} + \mu + \varepsilon
 \end{aligned}
 \tag{2}$$

Econometrically, the general model specification is represented by equation 2. The equation incorporates the complementarity variable to allow an investigation into the role of human capital development in the infrastructure-poverty nexus.

The vicious cycle of poverty as supported by Seetanah et al. (2009) considered the endogeneity nature of the poverty data is included in equation 3.

$$\begin{aligned}
 \text{POVERTY}_{it} = & \beta_0 + \beta_1 \text{POVERTY}_{it-1} + \beta_2 \text{INFR}_{it} + \beta_3 \text{HCD}_{it} + \beta_4 (\text{INFR}_{it} \cdot \text{HCD}_{it}) + \beta_5 \text{FDI}_{it} + \beta_6 \text{FIN}_{it} \\
 & + \beta_7 \text{REMIT}_{it} + \beta_8 \text{GROWTH}_{it} + \beta_9 \text{SAV}_{it} + \mu + \varepsilon
 \end{aligned}
 \tag{3}$$

Fixed effects were used to estimate equation 2 whilst the dynamic GMM approach technique was employed to estimate equation 3.

5. Correlation Analysis and Descriptive Statistics

Table 3. Correlation studies

	POV	INFR	HCD	FDI	FIN	REMIT	GROWTH	SAV
POV	1.00							
INFR	-0.65***	1.00						
HCD	-0.80***	0.45***	1.00					
FDI	-0.29***	0.11	0.16*	1.00				
FIN	0.01	0.29***	-0.02	-0.04	1.00			
REMIT	0.50***	-0.25***	-0.66***	-0.24***	-0.31***	1.00		
GROWTH	-0.65***	0.81***	0.56***	0.11	0.29***	-0.46***	1.00	
SAV	-0.31***	-0.01	0.02	0.22***	-0.10	0.07	-0.13	1.00

Source: Author

The correlation relationship between poverty as a dependent variable and its explanatory variables is as follows: There is a significant negative relationship between (1) infrastructure development and infant mortality rate, (2) human capital development and infant mortality rate, (3) foreign direct investment and infant mortality rate, (4) economic growth and infant mortality rate and (5) savings and infant mortality rate. These results indicate that infrastructure development, human capital development, foreign direct investment, economic growth and savings may have a poverty reduction effect, consistent with a clear majority of empirical research. A non-significant positive relationship was observed between financial development and infant mortality rate whilst the correlation between infant mortality and personal remittances was found to be significantly positive. The weakness of these correlation results is that they are not conclusive because they fail to observe the direction of causality between the variables under study. It is for this reason that this study is empirically investigating the existence of a unidirectional causality relationship running from infrastructure development to poverty in emerging markets. The correlation between human capital development and infant mortality rate is 80% absolute value. Correlation relationship between infrastructure development and economic growth was positive 81%. These correlation results exceed 70%, indicating the existence of a multicollinearity problem, in line with Stead (2007).

Table 4. Descriptive Statistics

	POV	INFR	HCD	FDI	FIN	REMIT	GROWTH	SAV
Mean	29.20	25.52	0.71	2.23	64.34	0.77	5058.17	28.13
Median	26.90	12.30	0.72	1.93	52.76	0.24	3864.42	28.00
Maximum	82.20	88.21	0.85	9.68	182.43	4.17	15974.64	51.09
Minimum	4.10	0.01	0.45	0.01	13.27	0.03	301.16	15.09
Standard. deviation	18.82	27.14	0.08	1.55	37.23	1.10	3911.46	10.14
Skewness	0.75	0.74	-0.78	1.14	0.82	1.67	0.70	0.60
Kurtosis	2.91	2.10	3.11	5.49	2.93	4.17	2.58	2.30
Jarque-Bera	13.49	18.14	14.71	68.65	16.47	75.72	13.00	11.54
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Observations	145	145	145	145	145	145	145	145

Source: Author

The data for all the variables is not normally distributed as shown by the probability of the Jarque-Bera criteria which is equal to zero. The rest of the variables are positively skewed except human capital development data which is negatively skewed. This skewness results indicates that the data for all the variables is not normally distributed. The data for economic growth is an outlier because its standard

deviation (3,911.46) far much exceeds the standard value of 100. The range for financial development and economic growth also exceeds 100, further evidence that there exists an outlier in the economic growth and financial development data set. In agreement with Aye and Edoja (2007), all the data sets were then transformed into natural logarithms in order to address the negative effects on final results created by multicollinearity problem, extreme values in the data set and the data which is not normally distributed.

6. Results Presentation, Discussion and Interpretation

Table 5. Unit roots - Individual intercept

Level stage				
	Levin et al. (2002)	Im et al. (2003)	ADF (Augmented Dick Fuller)	PP (Phillip Perron)
LPOV	1.44	3.29	9.17	8.78
LINFR	-8.84***	-7.09***	65.00***	80.64***
LHCD	-3.72***	-3.35***	30.30***	35.20***
LFDI	-2.24**	-3.60***	32.55***	53.54***
LFIN	-0.57	0.76	5.18	9.61
LREMIT	-2.73***	-2.70***	23.45***	29.68***
LGROWTH	-0.29	1.29	3.85	5.45
LSAV	-0.99	-1.86**	19.65**	16.14*
First difference stage				
LPOV	-2.41***	-1.69**	16.16*	20.28**
LINFR	-3.53***	-3.25***	28.24***	33.49***
LHCD	-10.50***	-10.31***	96.35***	130.16***
LFDI	-3.68***	-6.90***	62.20***	110.58***
LFIN	-3.21***	-4.12***	37.00***	74.41***
LREMIT	-10.61***	-9.51***	83.54***	93.88***
LGROWTH	-5.18***	-4.34***	36.99***	46.76***
LSAV	-4.34***	-4.75***	42.70***	71.45***

Source: Author

The data was integrated of order 1 (see results in Table 5), hence paving way for panel co-integration tests whose results are presented in Table 6.

Table 6. Johansen Fisher's approach

Hypothesised number of co-integrating equations	Fisher's trace test	Probability	Fisher's max-eigen test	Probability
None	697.8	0.0000	161.1	0.0000
At most 1	281.8	0.0000	215.5	0.0000
At most 2	228.0	0.0000	106.0	0.0000
At most 3	155.4	0.0000	67.48	0.0000
At most 4	104.9	0.0000	61.87	0.0000
At most 5	55.10	0.0000	31.17	0.0005
At most 6	35.14	0.0001	26.58	0.0030
At most 7	26.81	0.0028	26.81	0.0028

Source: Author

Table 6 produced results which show that the variables used in this study are con-integrated (have a long run relationship). Such results allowed main data analysis to be undertaken, in line with Tsauroi and Ngcobo (2020).

Table 7. Determinants of poverty reduction - Fixed Effects

	Model 1	Model 2	Model 3
LINFR	-0.14***	0.03***	0.01
LHCD	-0.92***	0.44***	0.17*
INTERACTION TERM	-0.22***	0.018***	0.02**
FDI	0.03**	-0.002	0.002
FIN	0.05	-0.001	0.07***
REMIT	0.02	-0.01	-0.01***
GROWTH	-0.26***	-0.04***	-0.04***
SAV	-0.39***	-0.04**	-0.37***
Adjusted R-squared	0.9714	0.9435	0.9328
F-statistic	263.39	98.02	209.22
Prob (F-statistic)	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.

Source: Author’s compilation from E-Views

Model 1 used infant mortality rate (per 1,000 live births) whilst model 2 employed total life expectancy at birth (years) as proxies of poverty. The poverty proxy used in model 3 is household consumption expenditure as a ratio of GDP.

Fixed effects (Table 7) produced results which show that infrastructure development significantly reduced infant mortality and life expectancy but not significantly enhanced household consumption expenditure. These results indicate that infrastructure development reduced poverty, consistent with theoretical literature which argued that developed infrastructure which improves people’s access to good health, education, roads and clean water enables the populace to engage in more meaningful poverty alleviation linked economic activities (Parker et al., 2008). Empirical research which also supported the infrastructure development-led poverty reduction include Achjar (2010), Jerome (2011), Qin et al. (2022), Fagbemi et al. (2022), Owusu-Manu et al. (2019), Husnah et al. (2023).

Human capital development significantly reduced infant mortality rate, improved life expectancy and household consumption expenditure hence providing unequivocal evidence that human capital enhances poverty reduction. The results resonate with theoretical studies which argued that skilled and educated people have better chances of securing employment, earning high levels of income, save, invest and increasing their wealth (Afzal et al., 2010).

The interaction term also noted that infrastructure development had a significant negative effect on infant mortality rate, significant positive influence on life expectancy and household consumption expenditure. These results indicate that human capital development enhanced infrastructure development’s ability to significantly reduce poverty, consistent with empirical studies done by Mallek et al. (2014) and Nugrobo (2015) in the context of Africa and Indonesia respectively.

Foreign direct investment had a significant positive effect on infant mortality rate, results which indicates that FDI increased poverty in emerging markets during the period under study. Although these results contradict majority of theoretical and empirical research, they resonate with Romer (1986) whose

study argued that over relying on FDI inflows as a means of fighting poverty can backfire in the long run.

Financial development had a significant enhancing influence on household consumption expenditure (model 3). The results show that financial development reduced poverty, consistent with World Bank (2001) which noted that a developed financial market enables people to access loans at an affordable cost from a variety of financial institutions to carry out their income generating and wealth creation small projects.

Personal remittances' impact on household consumption expenditure was found to significantly negative. The results mean that personal remittances increased poverty, in line with Anyanwu and Erhijakpor (2010) whose study noted that over reliance on personal remittances inflow increases poverty in the long run.

Economic growth significantly reduced infant mortality rate hence lowering poverty levels, in line with Dunning (1988) whose study argued that economic growth reduces poverty through its ability to increase return on investment and attracting more FDI inflows. Economic growth significantly reduced total life expectancy and household consumption expenditure hence exacerbating poverty levels in emerging markets. The findings although contradicting majority of empirical research, they resonate with Kuznets (1995) whose study explained that low levels of economic growth stage is always associated with higher poverty levels.

Savings reduced infant mortality in a significant manner, in line with Steinert et al. (2017) whose study noted that savings leads to investment returns hence it is a sustainable way upon which poverty alleviation can be premised upon.

Table 8 shows the Dynamic GMM results for the paper.

Table 8. Dynamic Generalised Methods of Moments (GMM) Results

	Model 1	Model 2	Model 3
<i>POVERTY</i> _{<i>i,t-1</i>}	0.99***	-0.99***	-0.95***
LINFR	-0.004	0.001	-0.02***
LHCD	-0.04	0.003***	-0.07**
INTERACTION TERM	-0.003	0.001	-0.02***
FDI	-0.01**	0.002*	0.001
FIN	0.002	-0.003	-0.01**
REMIT	-0.004	-0.0003	0.01**
GROWTH	0.003	0.004**	0.03***
SAV	-0.03***	0.005	-0.01*
Adjusted R-squared	0.9915	0.9828	0.9756
J-statistic	136.00	136.00	136.00
Prob (J-statistic)	0.00	0.00	0.00

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.

Source: Author's compilation from E-Views

The dynamic GMM approach shows that the lag of poverty significantly (1) increased infant mortality, (2) reduced total life expectancy and (3) decreased household consumption expenditure. The results indicate that the lag of poverty increased poverty levels, in support of the vicious cycle of poverty theoretical rationale supported by Seetanah et al. (2009).

Infrastructure development had a non-significant poverty reduction influence on infant mortality and an improving non-significant effect on life expectancy. Although weak, the results generally support theoretical literature which says infrastructure development reduces poverty (Schachtebeck & Mbuya, 2006; Meilvidiri et al., 2020; Nkoa et al., 2022). On the other hand, infrastructure development reduced household consumption expenditure in a significant way. The results mean that infrastructure development increased poverty, in contradiction with majority of theoretical and empirical literature available.

Human capital development non-significantly reduced infant mortality rate and significantly improved total life expectancy. The results resonate with Afzal et al. (2010) whose study explained how human capital development enhances poverty alleviation. In contradiction with available, human capital development was found to have significantly reduced household consumption expenditure, a finding which shows that the development of human capital exacerbated poverty levels.

The interaction term indicates human capital development non-significantly enhanced infrastructure development's ability to reduced poverty as proxied by infant mortality rate and life expectancy. Although the results are non-significant, they generally support earlier empirical research by Mallek et al. (2014) and Nugrobo (2015).

FDI significantly reduced poverty when it's proxied by total life expectancy and infant mortality rate, in support of majority of literature on FDI-led poverty hypothesis. Financial development was found to have only significantly reduced household consumption expenditure, a finding which show that developed financial sector increased poverty levels. The results agree with Boukhaten (2016) whose study noted the difficulties in obtaining small loans by the poor due to lack of collateral security as the financial sector becomes more and more developed.

Personal remittances significantly increased household consumption expenditure, in line with existing theoretical literature which argues that the inflow of personal remittances is channelled towards self-help projects, education, skills development and health at household level, all of which contributes towards poverty alleviation (Cattaneo, 2005).

Consistent with Dunning (1988), whose study supported the economic growth led poverty reduction hypothesis, this study using the dynamic GMM noted that economic significantly increased both household consumption expenditure and life expectancy. Savings significantly reduced infant mortality, consistent with Steinert et al. (2017) whose study argued that savings leads to investment which brings in return to investment and wealth generation over time. In contradiction to literature, savings increased poverty when household consumption expenditure was used as a proxy of poverty.

7. Conclusion

The study explored the impact of infrastructure development on poverty alleviation in emerging markets, it also studied the influence of human capital development in the infrastructure development-poverty reduction nexus. Specifically, whether human capital development is a channel through which poverty alleviation is influenced by infrastructure development in emerging markets. The study used fixed effects and the dynamic GMM approach with panel data from 1993 to 2021. Fixed effects show that infrastructure development significantly reduced poverty when infant mortality and life expectancy were

used as proxies. On the contrary, the dynamic GMM approach noted that infrastructure development non-significantly decreased poverty using life expectancy and infant mortality rate as measures of poverty. Emerging markets should therefore implement infrastructure development enhancement policies to alleviate poverty. Fixed effects indicate that the interaction between infrastructure and human capital development significantly reduced poverty across all the three measures of poverty. The dynamic GMM however found out a non-significant poverty alleviating impact influenced by the interaction between infrastructure and human capital development (when infant mortality rate and life expectancy proxies of poverty are used). Emerging markets should implement joint human capital and infrastructure development policies to enhance poverty alleviation. The study also encourages future empirical research on exploring threshold levels of infrastructure development necessary to significantly improve poverty alleviation. It also encourages investigating human capital development threshold levels that helps infrastructure development to significantly alleviate poverty in emerging markets.

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