

Title

Investment infrastructure and development assistance impact on headcount poverty reduction in Nigeria: Auto-regressive distributed lag (ARDL) approach

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Abstract

This research analysis includes past and future expectations, which are vital and addresses the following question to examine the relationship between infrastructural investment and the effects of development assistance on poverty headcount reduction? The dynamic relationship between infrastructure investment (percentage of the gross fixed investment) and foreign aid (percentage of net official development assistance) on poverty reduction (headcount) proved inconclusive using four lags. The auto-regressive distributed lag (ARDL) model results revealed an inconclusive, rather impactful relationship and significantly supported the model's efficiency during the study period. Despite the relationship inconclusiveness, it indicated that foreign aid or official assistance was impactful to the optimum in the past and present. Investment in infrastructure was crucial for reducing the poverty headcount in the Nigerian economy. The policy implications suggested that net official assistance inflows and infrastructural development could foster an excellent avenue for foreigners to invest more in the country, bringing capital stock, employment opportunities, and increased per capita income. To boost trade openness, employment, and growth, especially in rural areas, enhances urban development or improve living standards.

Key words

infrastructure, foreign aid, poverty reduction, Nigeria, ARDL

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Introduction and Background

Infrastructure investment defines the construction, provision, and fundamental improvement of services to spark economic growth and improve people's lives. Foreign aid typically supports developing or low-income countries with security and economic growth, political and social development. Africa Social Work Network, (2021) emphasizes that aid or development assistance is crucial for leading to the social and economic benefit to the poor, important for quasi-governmental institutions like universities and regional institutions like the African Union, problematic due to corruption and bad governance.

Infrastructural development, foreign aid, and poverty reduction are resources targeted to increase social service to the poor. Investments in infrastructure raise total capital formation, and new technology leads to poverty reduction. Jerome (2011) mentioned that the infrastructure sector in Nigeria is part of the regulatory package for the need of the poor. Therefore, the country's inadequate supply of infrastructure services has been depressing Nigeria's economic development and poverty reduction over the last two decades. Nevertheless, an increase in foreign aid by the international community should help the country to develop faster to the extent that infrastructure and foreign investors will crowd in private investment that can foster productivity, employment, and per capita income and reduce poverty. Infrastructure development is evident because it means a second feature after government budget/expenditure to determine a nation's competitiveness (Chotia & Rao, 2017).

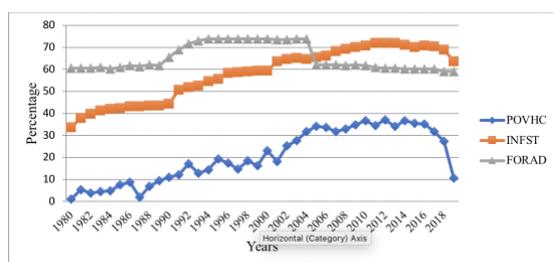
The notion that infrastructure matter for reducing poverty is due to the binding contribution effect it brought to societal

development and improvement for social welfare, more especially to influence poverty reduction (Asadullah & Savoia, 2018). In developing countries, infrastructure matters for rural and urban investments and growth, leading to higher productivity, employment, and income opportunities, reducing poverty headcount and rising mean income and consumption. Infrastructure development and foreign aid are effective institutions included in the sustainable development goals dependent on causing a poverty reduction. However, the determinants for achieving the Millennium Development Goal (MDG) goal for halving poverty reduction or total eradication remained debatable in the literature, particularly in infrastructural development in developing countries. The significance of foreign direct aid remained on search (Dalgaard & Erickson, 2009).

Infrastructure and foreign aid are the main fundamental factors contributing to saving people's lives in developing and developed countries alike (Jelilov & Akyuz, 2020). It addresses the problems of poor vulnerability to access free health care and education neglected as a policy. Possible for some developing or low-income countries to significantly reduce poverty (headcount) and achieve the millennium development goals by fostering political, social and economic dynamic growth policies involving infrastructure services accessibility by the poor in terms of education, healthcare, and agricultural inputs. A study conducted in Nigeria by Urama et al (2019) convinced that despite the various poverty reduction programmes and strategies adopted, millions of people are sliding into extreme poverty, which is an apparent ineffectiveness of the policies. Indeed, spending on education will boost innovation and creativity, ultimately growing employment.

This research and following the Keynesian theory of government spending for infrastructure development can serve a role in poverty headcount reduction or alleviation to derive an exogenous factor model that can be utilized as a policy instrument variable to promote the reduction of headcount poverty through investment infrastructure. To an extent provide insight into whether regression analysis can estimate a robust positive correlation between infrastructural investment, foreign aid, and poverty headcount reduction. Therefore, the study will use data sourced from world development indicators to measure the indicators for finding a relationship between infrastructure investment, foreign aid inflow, and poverty reduction. The data estimates the short and long term between infrastructure development and flow of foreign aid in reducing poverty level (headcount) within forty years (1980 to 2019) in the country. A plot of the indicators data is presented in Fig 1 below to notice the relationship and term trend.

Figure 1. Relationship between infrastructure, foreign aid inflow and poverty reduction in Nigeria



Source: process data (World Development Indicator, 2021)

In this research, a relationship between the research problem is poverty reduction to explain by investment in infrastructure and foreign aid inflows. Figure 1 represents the trend between the indicators of investments in infrastructure and foreign aid on poverty

headcount reduction from 1980 to 2019. In contrast, poverty fell to 10.61% in 2019. It is an indication of an efficient relationship.

Literature review

Poverty is very high in Africa and Nigeria, which made the country receive sufficient aid, as indicated in the data throughout the research that is forty years. Unfortunately, the lack of good and sound policies prevents the aid from functioning correctly to alleviate poverty or infrastructural investment. Foreign aid is not a negative issue until it generates higher returns, especially investment in infrastructure to enhance capacity building in communication and technology to improve output growth (Dey & Tareque, 2020). Foreign aid considers an effective tool for reducing inequality and promoting economic development (Younsi et al., 2019). Finding out from the works of literature reviewed in this research, it becomes applicable to incorporate the indicators into auto-regressive distributed lag (ARDL) models to measure the relationship between infrastructure investment, foreign aid inflows and poverty reduction. The model evaluates the stability present and future of foreign aid inflows in the study period, which is forty years the short and long term impacts.

Investment in infrastructure is an issue that is urgent and required by developing countries, especially Nigeria. It will attract more foreign investors to foster economic growth that infrastructure development depends on foreign investment (Pradhan et al., 2013). Using the ARDL approach, India has a long-run relationship between infrastructure, foreign investment, and economic growth. What accelerates the inflows of foreign investment is the presence of infrastructure. Therefore, investment infrastructure can foster foreign

investment to provide more employment and increase per head income. Investment in infrastructure from a study in India by Chotia et al. (2017) reported in their results after running the ARDL technique that there is a strong link between infrastructure development and poverty reduction. The causality test confirmed the existence of an optimistic and unidirectional causality running from infrastructure development to poverty reduction. Therefore, Nigerian societies need the government's intervention to eradicate poverty because their source of dependence for survival includes access to primary resources directly from the infrastructure or collective human settlement.

Mahalik et al. (2021) conducted in India observed the relationship between foreign aid and foreign energy inflows on environmental hazard/economic growth. The results based on the ARDL bound test proved the existence of a long-run relationship and significance among the variables. The study suggested that, since foreign aid and foreign direct investment inflow induce economic growth, policymakers should focus on receiving foreign inflows to improve environmental quality. Even in the country (Nigeria), infrastructure needs developing because it is the biggest challenge that remains or give access to the poor to socialize, for which financing is limited (Iyoha & Oyerinde, 2010). This study will take note of the challenges or the issues, which is not enough for the poor to feel the impact of infrastructure. In a Pakistan study, Rehman et al. (2020) observed that infrastructure investment plays a tremendous role in attracting foreign investment because a well-developed infrastructure enhances markets integration. Their results, employing the ARDL approach, suggested that cointegration among the variables infrastructure is vital for attracting foreign

investors. Similarly, Akobeng (2020), a study from Ghana, suggested that foreign aid reduces poverty but not at the headcount level and different components of foreign aid have other effects on poverty. Further, the study reveals that foreign aid contributes more in a country with a democratic dispensation because it alerts policymakers that the effectiveness of foreign assistance/aid serves as an essential mix toward the achievement of sustainable development goals.

Aluko et al. (2010) conducted a study in Nigeria that developing countries are needed for foreign aid because it can contribute to their development due to the presence of foreign investors in the developing countries' economy and infrastructural development is relatively weak because of poor capital base. Moreover, foreign aid improves financial sector development and helps in alleviating or reducing income inequalities toward stimulating economic growth (Younsi et al., 2019). Besides, foreign aid has taken a central stage in the near past and world affairs because of the argument whether or not foreign aids can complement infrastructure investment that can reduce developing nations' poverty (Okoronkwo et al., 2016). Mahembe et al. (2020) captured that foreign aids can reduce poverty through economic growth investing in infrastructure.

This research realizes that there is hardly mention of the relationship between investment in infrastructure, foreign aid inflows between past and future on headcount poverty reduction in most literature reviews, except Jelilov et al. (2020) that study the effects of foreign aids, infrastructural development and poverty in Nigeria. Their results found that foreign aid has a strong relationship with infrastructural development, which

positively impacts poverty reduction both in the short and long run. The interaction between foreign aid and infrastructural development negatively affects poverty reduction. They used the concepts or variables of foreign aid as total official development assistance (constant US\$), infrastructural development proxy as whole electricity net generation and poverty proxy as household consumption per capita in Nigeria. This research employs investment in infrastructure proxy as a gross domestic fixed investment on road construction, railways, etc. Foreign aid or official net assistance considers inflows in dollars and poverty as headcount ratio (international poverty line) all in per cent.

Methods and variables description

This research employs annual time series data from 1980 to 2019 from the World Development Indicators following the studies of (Akobeng, 2020; Collier & Dollar, 2002; Jelilov & Akyuz, 2020; Lin & Domemeland, 2012; Mahembe & Odhiambo, 2019). This research specifically model poverty reduction headcount population that are poor and cannot afford \$1.90 per day (POVHC) as dependent variable followed by gross fixed capital formation as investment infrastructure (INIF) and foreign aid/official development assistance (FORD) in equation (1). It will empirically establish a linkage between the indicators of investment in infrastructure or fixed investment on road construction, railway, etc. and foreign aid, inflows of net assistance all in percentage. In addition, equation (1) model is the intercept, coefficients and error term. The typical signs of the coefficients are positive investment infrastructure and negative foreign aid.

$$POV_t = \beta_0 + \beta_1 INIF_t - \beta_2 FORD_t + \varepsilon_t \quad (1)$$

In order to estimate the long-run relationship between the series based on the equation (1) above, this research will use Auto-regressive distributed lag (ARDL) bounds to test the approach (Pesaran et al., 2001) for cointegration which has more merit over the model efficiency. Secondly, using the cointegration model will provide this research with the presence of stationarity; overcome the problem of spurious regression. Thirdly, it reduces the problem of endogeneity among the variables during the estimation, which often (Pesaran and Shin, 1999; Pesaran, 2008). Equation (2) describes the expanded ARDL bounds testing model in line with the variables reports in equation (1). It will enable the study to examine the long-run relationship between the variables as follows:

$$\Delta POVHC_t = \beta_0 + \sum_{i=1}^k \beta_{1i} \Delta POVHC_{1t-i} + \sum_{i=1}^k \beta_{2i} \Delta INIF_{1t} - \sum_{i=1}^k \beta_{3i} \Delta FORD_{1t-i} + \beta_{4i} POV_{t-1} + \beta_{5i} INIF_{t-1} - \beta_{6i} FORD_{t-1} + \mu_t \quad (2)$$

After estimating the long-run relationship between the variables as stated in equation (2) is confirmed, the research can then derive the short-run coefficients which could be estimated based on the underlying error correction model (ECM) to correspond to the research main long-run I equation (2) as follows:

$$\Delta POV_t = \beta_0 + \sum_{i=1}^k \beta_{1i} \Delta POVHC_{1t} + \sum_{i=1}^k \beta_{2i} \Delta INIF_{1t} - \sum_{i=1}^k \beta_{3i} \Delta FORD_{1t} + \beta_{4i} POV_{t-1} + \beta_{5i} INIF_{t-1} - \beta_{6i} FORD_{t-1} + \varphi ECT_{t-1} + \mu_t \quad (3)$$

In equations (2) and (3), k stands for optimal lag length of variables and it means the first difference of the variables β_0 represents the vector of constant, β_t are the coefficients of explanatory variables under estimation. $POVHC_{1t}$ is a vector of response variable, $INIF_{1t}$ and $FORD_{1t}$ are the vector of predictors whereas φ is indicating the speed of adjustment coefficient of the error term (ECT_{t-1}) and of course μ_t stand to explain the residual or

error term. Therefore, in both the equations components are explaining the long-run and short-run causal relationship or elasticity of the variables. In ARDL bound test estimation the null and alternative hypothesis for cointegration among the variables are represented as $H_0: \beta_4 = \beta_5 = \beta_6 = 0$ and the corresponding alternative hypothesis is $H_1: \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$. In finding the coexistence of cointegration among the variables, the computed *F*-statistics is compare with the critical values (Narayan, 2005). When carrying out the estimation the study will consider choosing both the values in the upper or lower critical bounds where the inference to compare cointegration among the variables as I is (0) and I (1) respectively. In comparing the presence of cointegration between the upper and lower values will determine the study to validate whether conclusive or inconclusive outcome. According to Banerjee et al. (1998) error correction term is essential as a helpful mechanism in determining the short-run adjustment between the variables. The error correction term coefficient magnitude will indicate to the study how many years it can take to reach long-run equilibrium, convergence rate or poverty headcount reduction. For instance, if the convergence rate is the high speed of adjustment to equilibrium is lesser to short-run. It becomes practical to stabilize investment infrastructure to reduce poverty. The sign should be negative and significant coefficient of the error correction term to provide the existence of long-run.

Empirical results and discussions

In Table 1 portrays the results for unit root test and it is concerns with ADF and PP that will reveal the agreement of the tests all variables are stationary in the level data by

1% and 10%critical level. Similarly, this research has noticed more in the Table 1 below indicating the unit root test, which is integrated at 1% and 10% significant level. The probability as highlighted all the values are at random before integration. When the variables are integrated of I (0), I (1) or mixed it will be perfect to run cointegration (ARDL Model) tests.

Table 1: Unit root test

Variables	ADF test		PP test	
	Intercept	Trend and intercept	Intercept	Trend and intercept
Level				
POV	-2.938987	-3.533083	-3.610453	-3.196411
p-value	(0.4858)**	(1.0000)*	(0.4795)**	(1.0000)*
INIF	-2.938987	-3.529758	-2.938987	-3.196411
p-value	(0.0604)*	(0.9999)*	(0.856)*	(1.0000)*
FORD	-2.938987	-3.529758	-2.607932	-3.529758
p-value	(0.7389)*	(0.8931)*	(0.6490)*	(0.8738)*
First difference				
POVHC	-2.610263	-4.219126	-3.615588	-4.219126
p-value	(0.4560)**	(0.0002)***	(0.0001)***	(0.0001)***
INIF	-2.941145	-4.219126	-2.941145	-4.219126
p-value	(0.0128)**	(0.0084)***	(0.0128)***	(0.0078)***
FORD	-3.615588	-4.219126	-3.615588	-4.219126
p-value	(0.0001)***	(0.0004)***	(0.0001)***	(0.0004)***

Source: Researchers computation

*** Significant at 1% level

** Significant at 5% level

*Significant at 10% level

ARDL bound test

Based on four automatic optimum lag and model selection, the dependent variable of infrastructure development is positive, foreign aid or official assistance inflows is negative, and both are statistically significant. The signs between infrastructure development and foreign aid inflows explain that both are beneficial except that foreign aid does not influence poverty reduction like infrastructure development, which is both essential on headcount poverty reduction. In the case of R-square and adjusted R-square, that 87% variation has explained the study variables.

In determining the bound test, which is the long-run relationship between poverty headcount reduction, investment infrastructure and foreign aid inflows

variables, all the variables move together to correct the short-run disturbance from the long-run trend. Table 2 below report the calculated F-statistic with critical values that described inconclusive results because it is between the upper and lower level at 5% significance.

Table 2: ARDL bound test results

Model	F-statistics	Conclusion
POV=INIF, FORD	3.121532**	Inconclusive
significant	I(0)	I(1)
10%	2.63	3.35
5%	3.1	3.87
1%	4.13	5

Source: Researcher computation

***Significant at 1% level

**Significant at 5% level

*Significant at 10% level

In table 3, the coefficient of infrastructure development reveal that a 1% increase from infrastructural development and foreign aid contributes to poverty headcount reduction by a 1% and 0.325% at 1% significant level. The error correction term is negative and significant at a 1% level, indicating the proof for a steady long-run relationship. However, these findings corroborate with the study of Dey et al. (2020) and Akobeng et al. (2020) that the indicators explain relationship and impact on poverty reduction. The value of the error correction term is -1.40 proposing that there is a deviation from the long-run rate of convergence in one year corrected by -1.40%. It becomes evident that there is a long-run relationship since the coefficients and probabilities are valid. Moreover, the cointegration behaviour probability is at a 1% significant level. Lastly, there is the coexistence of relationships among the variables.

Table 3: Cointegration and long-run coefficients

Short Run Cointegration				
Variable	Coefficient	Standard error	t-statistic	Prob.
INFST	1.0025***	0.044124	22.72013	0.0000
FORAD	0.3252***	0.092104	-3.536535	0.0013
C	-17.1330***	6.482357	-2.643019	0.0128
Short Run and Long Run Cointegration				
	Coefficient	Std. Error	t-statistic	Prob.
CointEq (-1)	-1.407227	0.380270	-3.700603	0.0008

Author’s computation

Note: ***indicates significance at 1%, ** significance at 5% level, * significance at 10% level.

Diagnostic test

Table 4 shows the short-run model to clear the issue of inconclusive results of the relationship or model efficiency. Therefore, diagnostic tests reveal how the model passes serial correlation (Breusch-Godfrey), heteroskedasticity, and standard tests. The Ramsey RESET test similarly suggests that the model is fit, efficient and well specified. The normality test shows a slight disturbance in the model.

Table 4 Diagnostic test for short run model

Short run		
Tests	F-statistic	P values
Breusch-Godfrey serial correlation LM	0.0998	0.8811
Heteroscedasticity test	1.5103	0.2029
Jacque Bera Normality Test	10.4363	0.0054
Ramsey Rest Square of fitted values	9.1571	0.0050

Source: Author’s compiled results

Policy implications

The investment infrastructure and foreign aid are essential inputs in reducing headcount poverty in an economy like Nigeria. The flow of foreign aid is either steady or not yielding much result in reducing headcount poverty. While infrastructural investment is slightly constant despite the inflows of foreign aid in the country. Foreign aid inflows are

supposed to contribute to the expansion of recurrent government (spending) expenditure at the expense of boosting infrastructural development. This research realizes that short-run and long-run poverty reduction exists based on the study of Jelilov et al. (2020). Their estimation results prove uncertain when this research re-estimates using an indicator of poverty headcount for 40 years, and investment infrastructure becomes positive and foreign aid inflows negative sign, it changed and explained in detail the reason for inconclusive. The investment infrastructure and foreign aid are not leading to the Nigeria policy for poverty reduction on headcount or ordinary income (\$1.90) for global comparison. This research proves that estimates and tests for the model efficiency are pessimistic and significantly correlated, making the model acceptable. Therefore, stabilize the economy and reduce headcount poverty by meeting the global standard through government spending in gross domestic fixed capital infrastructural development to improve living standards, enhance market size through fiscal policy and improve per head income. Secondly, the official assistance in foreign aid inflows was positive in the past and significant in the future rather substantial when explaining headcount poverty reduction instead. The development assistance might be helpful when it becomes available and adequately managed for the investment in infrastructure to spur job opportunities for employment, productivity and economic growth.

Conclusion

What is new or novel about this research is the relationship that reveals positive and non-negative signs during auto-regressive distributed lag tests linearity on leading

headcount poverty reduction in the future and, more importantly, significant to the economy. Hence, headcount as a poverty reduction indicator can be achieved in Nigeria when the government convert foreign net official assistance into developmental activities. Future research recommends causality investigation on the performance of foreign aid and investment infrastructure as indicators for poverty severity. This study suggests that further research should include trade openness as an additional indicator to find a relationship.

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