E u r o E c o n o m i c a

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Gross Capital Formation, Infrastructure, and Economic Development in Nigeria

Adegboyega Samson Opadeji[1], Oladimeji Olaniyi[2], Adewale Mathew Adekanmbi[3], Joseph Oluremi Olubitan[4]

Abstract: In Nigeria, the reduction in capital formation and the extent to which the dismal state of most infrastructure facilities, as well as their state of disrepair, impair the nation's growth potential are relatively unknown. Given this, this study utilizes the Johansen co-integration test and the Vector Error Correction Model to analyze the effects of gross capital formation and infrastructure in the development of Nigeria's economy from 1991 to 2021. The co-integration result revealed that the variables have a long-run relationship while the VECM result revealed that gross capital formation has not significantly impacted economic development while infrastructure had a significant positive effect on economic development in Nigeria during the study period. Based on the findings, the study recommends that the government and private sectors should collaborate so as to provide an enabling environment that will enhance capital investments in the economy. Also, gross capital formation should be efficiently channeled with a sizable amount accorded to infrastructural development which in turn translates to economic development.

Keywords: Gross Capital Formation; Economic Development; Infrastructure; Nigeria; VECM

JEL Classification: H41; H54; O11

1. Introduction

The recent globalization across nations has facilitated greater achievement of macroeconomic goals, which, while not automatic, do necessitate governmental guidance and give adequate contributions to varied economic forces (Adefeso & Bolaji, 2010). As a result, both economists and policymakers have been paying close attention to the debate over economic progress.

As a development policy objective, all governments throughout the world, particularly African states like Nigeria, have emphasized quick, sustainable, and pro-poor economic growth and development. After six decades of independence, Nigeria's economy has tremendous challenges in terms of attaining sustained economic growth, alleviating poverty, and lowering unemployment (Okuneye et al., 2023). The economy remains mostly focused on primary products, heavily dependent on imports, consumption-driven, and lacks diversification. Despite the availability of natural resources such as oil and gas, 68 percent of the country's nearly 170 million population lives below the international poverty line of US$

[1] Dominion University Ibadan, Nigeria, E-mail: s.opadeji@dominionuniversity.edu.ng.
[2] Olabisi Onabanjo University, Ogun State, Corresponding author: olaniyioladimeji18@yahoo.com.
[3] E-mail: adekbi@yahoo.com.
[4] Dominion University Ibadan, Nigeria, E-mail: j.olubitan@dominionuniversity.edu.ng.

1.25 per day (Opadeji et al., 2021). Agriculture employs approximately 70% of the workforce and generates 40% of GDP; more than 90% of exports and foreign exchange revenues are accounted for by crude oil.

A well-designed infrastructure, on the other hand, has been shown to provide economic benefits by boosting economic growth and productivity, as well as having a positive socio-economic impact (Pereira & Pereira, 2018). It can also be used as a catalyst to boost economic growth. Infrastructure, according to previous research, boosts economic activity since it is employed in practically every manufacturing process, including telecommunications, energy, water, and transportation. Thus, infrastructure, which is an input into all manufacturing processes, has a beneficial impact on economic growth, productivity, and growth rates (Almeida & Mendonca, 2019).

Infrastructure has three effects on economic development: it increases production and employment; it increases human capital and improves people's social lives by providing better facilities such as education and health; and, finally, it improves financial facilities such as monetary transactions, loans, and other services (Straub, 2008; Sahoo & Dash 2009; Shi et al. 2017; Olaniyi et al, 2023).

So far, no country has achieved long-term economic progress without substantial capital investment (Onyinye *et al.,* 2017; Ugwuegbe & Uruakpa, 2013). Poor infrastructure has a negative impact on economies in a variety of ways, including hindering market accessibilities, increasing amenities costs as well as business risks and uncertainties. In other developing economies, slower productivity growth is related to stagnating investment (International Monetary Fund, 2014; Palie, 2015; Asian Development Bank, 2017; Fay & Rozenburg, 2019; Fay et al., 2019).

Infrastructure has long been considered a necessary condition for industrialization and economic growth (Sawada, 2015). It is critical for poverty reduction, enhancement of economic growth, and the achievement of the Millennium Development Goals (MDGs). Savings, foreign direct investment, gross domestic product, interest rate, population growth, money supply, and exchange rate are some of the factors that influence capital formation (Jhingan, 2014; Soludo, 2014). Changes in any of these variables have an effect on capital formation, which has an effect on economic development. Appropriate investment, on the other hand, is required for economic growth and development; this means that any economy must amass a large amount of internally produced capital for investors; However, most African countries, including Nigeria, have struggled to provide the required capital, resulting in lower national output and revenue, as well as an increase in the vicious circle of poverty on both the demand and supply sides (Olaniyi & Adekanmbi, 2021).

Low capital formation is one of the challenges attributed to developing nations (Holtz-Eakin, 1993; Jhingan, 2006; Emeka et al., 2017). Gross capital formation promotes technological improvement, which supports the realization of large-scale production economies and promotes specialization through the provision of machinery, tools, and equipment for a rising workforce. However, macroeconomic imbalances and deficiencies in economic infrastructure, such as faulty electricity generation, poor road networks, and inadequate health and educational facilities, all contributed to a decline in capital formation in the Nigerian economy (Bakare, 2011; Siyan et al., 2015; Emeka et al., 2017; Younsi et al., 2021).

While the debate over gross capital formation and economic development has continued in the literature due to mixed and inconclusive submissions (Ugwuegbe & Uruakpa, 2013; Seidu et al., 2020; Farah et

al., 2020), scholars have paid little attention to the understanding of how such impacts or otherwise. However, studies such as Gruneberg et al., (2013) and Onyinye et al., (2017) contend that effective government commitment accelerates capital formation, while Zhou et al., (2021) confirm that infrastructure investment improves economic growth by facilitating the physical and material circulation of resources, market integration, and the evolution of knowledge capital. Thus, gross capital formation not only improves economic development; but the importance of infrastructure investment in the economy cannot be overestimated. However, given the aforementioned motivations and the lack of studies on the joint role of gross capital formation and infrastructure investment in Nigerian economic development, as well as the conflicting opinions in the literature, it is pertinent to state that these relationships require further investigation.

As a result, this study examines the combined effects of gross capital formation and infrastructure on economic development in Nigeria from 1991 to 2021. Telecommunications, electricity, and transportation, which form the foundation of public infrastructure, are inextricably tied to productivity (Estache et al., 2013; Almeida & Mendonca 2019). Using principal component analysis (PCA), a composite infrastructure index will be created from these three major infrastructures.

2. Empirical Literature

Gross capital formation is a component of GDP spending that shows how much newly created value is invested rather than consumed in the economy. It is the overall change in the value of the economy's fixed assets in relation to the increase in the capital formed. It shows how governments can influence the direction of other investments by crowding in investments in the desired direction. According to Onyinye et al., (2017), capital formation is the most essential component in economic growth since it reflects effective demand on the one hand while also creating productive efficiency for future output on the other. The strength of its drivers determines its impact on economic growth. However, its potential drivers include foreign direct investment (FDI), interest rates, savings, money supply, exchange rates and population growth.

According to Gaal and Afrah (2017), infrastructure investment is the basic equipment and structures required for a country, region, or organization to function properly, and it contributes to economic development by improving productivity and providing services that improve people's quality of life. Despite the fact that infrastructure development is not officially stated as an indicator for the Millennium Development Goals (MDGs), it is critical to achieving of many of the goals. Investment in infrastructure is crucial to a country's socioeconomic success. However, inadequate infrastructure hinders citizens' access to markets, as well as livelihood opportunities and services such as clean water, education, health, transportation, and communication, and hence hinders economic development (Olaniyi et al., 2023).

Reviewing empirical evidence on capital accumulation and economic growth, using multiple regressions, Kanu and Ozurumba (2014) found that gross fixed capital formation had no significant impact on Nigerian economic growth in the short run but had a significant relationship in the long run. Emeka et al. (2017) examined Nigeria's domestic investment, capital formation, and economic growth. The findings show a long-term significant relationship between domestic investment and capital formation and both boosted Nigeria's economy over the study period. In another study, Ajose and Oyedokun (2018) found a long-term significant relationship between capital accumulation and Nigerian

economic growth from 1980 to 2016. Seidu et al. (2020) examined how infrastructure investment affects UK economic growth. Infrastructure investment may help the UK economy despite Brexit uncertainty and potential economic damage. The findings imply that UK infrastructure investment is crucial for economic growth via producing jobs through factor productivity. However, the investment must be directed to regional opportunity areas that can unlock economic growth, optimize earnings, and boost growth in other regions. Olaniyi et al. (2023) used ridge regression to evaluate how physical infrastructure impacts Nigeria's economic performance from 1990 to 2019. Infrastructure considerably improved economic performance during the study. As a result, the Nigerian government and its agencies must constantly oversee infrastructure expenditure and adhere to due process in accordance with the underlying fiscal policy.

This study also considers recent studies on gross capital formation, infrastructure, FDI, and economic growth from various viewpoints. However, in both developed and developing countries, the relationship between these variables is largely mixed. Infrastructure and FDI reduced poverty in 29 Sub-Saharan African (SSA) nations from 1990 to 2017, according to Anetor et al. (2020). It was revealed that infrastructure, Gross Capital Formation, and FDI were insufficient to end poverty and boost economic growth. The study found that trade positively and significantly reduces poverty, notably in SSA. Conversely, Dutta et al. (2020) used GMM estimator system analysis and the instrumental variable approach on panel data from 2004 to 2009 to examine how gross capital formation affects government business climate regulation in 64 MENA and sub-Saharan African countries. The authors concluded that inadequate gross capital formation enhanced government restrictions thereby worsening the business environment. However, Wen and Shao (2019) showed that China's transport infrastructure can reduce inter-regional trade costs, enhance industrial development, and increase economies of scale. Highway development lowered manufacturing companies' inventory costs and boosted economic growth efficiency during the period. Zhou, et al. (2021) used regional panel data from 29 Chinese provinces to build a composite index PCA to examine how infrastructure investment affects economic growth. The regression results reveal that infrastructure spending in China has not crossed the threshold while there has been a great improvement in the growth of their economy.

3. Theoretical Framework and Model Specification

The Harrod-Domar growth model assumes that a country's saving rate, capital-output ratio, and capital accumulation influence its economic growth rate. Therefore, every economy must conserve a percentage of its national income, even if solely to replace worn-out or deteriorated capital goods such as equipment, buildings, etc. Nevertheless, in order to expand, additional investments that reflect net additions to the capital stock are required. As a result, any net additions to the capital stock, whether in human resources or other forms of productive investment, will result in equivalent increases in the flow of national production, GNP.

Mathematically, the growth model is stated as:

$$\frac{\Delta Y}{\mathrm{Y}} = \frac{S}{K} \tag{1}$$

Where $\frac{\triangle Y}{Y}$ is the growth rate of GNP, s represents the rate of savings, and k is the stock of capital.

The model simply states that in order for an economy to grow, savings and investment must take a given percentage of its GDP. The faster a country can grow depends on the greater its savings and investment. The inverse of the capital-output ratio, k, measures the actual rate at which a country can grow at any level of saving and investment, i.e. additional output from an extra unit of investment. Nonetheless, the inverse of capital-output ratio $\left(\frac{1}{k}\right)$ depicts the output-investment ratio. Thus, multiplying the new investment rate,$S = \frac{1}{Y}$, by its productivity, $\frac{1}{k}$, gives the national income growth rate. The shortcomings of the growth model which formed the basis of its criticism are: it is based on the assumption of exogeneity of all critical growth parameters, it neglects technical development as a factor that contributes to growth, and it does not account for decreasing returns when one factor grows in relation to another.

Specifically, this study adopted the popular Harold- Domar growth model and followed a multiple regression approach, thus the growth equation.

$$\frac{\Delta Y}{\mathrm{Y}} = G = \frac{S}{K} \quad (2)$$

Where ΔY= the rate of change of GNP: Y is the national income; G is GNP growth; S represents national savings ratio; K is the capital-output ratio.

In this study, RGDP is the dependent variable and is used to measure economic development, while gross fixed capital formation (GFCF) which represents national capital-output ratio, and infrastructure (INFRA) are independent variables. A composite index of infrastructure was developed from telecommunications, electricity, and transportation which are the basic public infrastructure with the use of Principal Component Analysis (see Yoantika & Susiswuo, 2021; Zheng & Rakovski, 2021). The Principal Component Analysis (PCA) is a multivariate decision-making technique that creates a composite index by objectively defining a real-valued function over relevant variables. The basic concept underpinning this method is that when several characteristics of a collection of events are observed, the characteristic with the most variation explains more of the variation in the dependent variable than a variable with less variation. As a result, the problem is determining the weights to be given to each of the variables in question. The weight given to each variable relies on the principle that the variation in the linear composites of these variables should be the maximum. This study adopted an *ex-post facto* research design and employed annual time series data from the Central Bank of Nigeria (CBN) and World Bank in World Development Indicators (WDI, 2022).

Expressing the equation to accommodate the variables of this study in structural form, we have

$$RGDP = f(GFCF, INFRA,) \quad (3)$$

The functional equation above is stated in a linear form and converted through pleasing the natural logs as;

$$lnRGDP = \beta_0 + \beta_1 lnGFCF + \beta_2 lnINFRA + \mu_t \quad (4)$$

Where β_1 and β_2 are parameters

4. Results and Discussion

Unit root test: This study utilized the Augmented Dickey-Fuller (ADF) statistic test to establish the existence of unit roots or otherwise in the data. The result presented in Table 1 showed that none of the variables were stationary at level I (0) but they were stationary at first difference I(1).

Table 1. Unit Root Test Result

Variables	Levels			First Difference			Order
	ADF statistics	Critical Value	P-value	ADF statistics	Critical Value	P-value	
logRGDP	-1.1737	-4.2967	0.8980	-3.6891	-4.3098	0.0394	I(1)
lnGFCF	0.2273	-4.2967	0.9971	-4.5009	-4.3098	0.0064	I(1)
lnINFRA	-1.9162	-4.3561	0.6175	-5.2704	-4.3098	0.0010	I(1)

Source: Author's Computation 2023

4.1. Co-integration Test

A co-integration test was performed using the Johansen (1988) approach to find out the existence or inexistence of a long-run relationship among the series of the same order of integration employed for this study. The results indicate one (1) co-integrating equation because at the significance level of 5%, the value of Trace Statistic (38.16428) is higher than that of the Critical Value (29.79707). Thus, the existence of on co-integrating vector among the considered variables in the equation implies a long-run relationship among them. The Johansen co-integration result is presented in Table 2.

Table 2. Johansen Cointegrationn Test Result

logRGDP, logGFCF, logINFRA			
Lags 1 to 3 (in first differences)			
Trend: Linear deterministic			
Hypothesized No. of C.Eqn(s)	**T- Statistic**	**Critical Value (5%)**	**P-values****
None *	38.16428	29.79707	0.0043
At most 1 *	13.29441	15.49471	0.1045
At most 2 *	5.208033	3.841465	0.0225

** 1 co-integrating equation at 5% significance level. ** P-values.*
Source: Authors' Computation 2023

4.2. Vector Error Correction Model

Based on the co-integration test result which indicated the existence of a co-integrating equation, the VECM is estimated to ascertain the speed of adjustment as well as the dynamic relationships associated with the study variables both in the short and long-run. The VECM result is presented in Table 3.

Table 3. Vector Error Correction Result

Error Correction	Co-efficient	Standard Error	T-statistics	Prob*
ECT	-0.216930	0.080538	-2.693517	0.0140
D(lnGFCF(-1))	0.201534	0.098728	2.041309	0.0546
D(lnINFR(-2))	0.042255	0.016942	-2.494117	0.0215

R-squared= 0.569336, Prob. (F-statistics) = 0.049081, DW= 2.1778
Decision rule: Reject the null hypothesis if the p-value is less than the critical value at 5%.
Source: Author's Computation 2023

From Table 3, the speed of adjustment of the study variables towards equilibrium in the long-run measured by the ECT has the expected negative sign (-0.216930) while the probability value of (0.0140) indicates statistical significance at a 5% significance level. Thus, gross capital formation and infrastructure have a long run impact on Nigeria's economic development from 1991 to 2021. However, in the short run GFCF with p value 0.0546 implies that gross capital formation does not significantly contribute to economic development in Nigeria within the study period. This negative result thereby agrees with the findings of Odo *et al.*, (2016) and Onyinye *et al*, (2017). While INFR with a p-value of 0.0215 indicates that infrastructure has contributed significantly to Nigerian economic development between 1991 and 2021. This result is consistent with the results of Olaniyi *et al.*, (2023); Ekeocha *et al.*, (2021), and Khan *et al.* (2020)

Also, the Adjusted R-squared is 0.569336 showing that 56.9 percent variation in the dependent variable is explained by the explanatory variables as 43.1 percent difference being explained by variables not captured by this model which is represented by error term μ_t. The probability value of F-statistics (0.049081) is less than 0.05, indicating that the explanatory variables have a statistically significant effect on the dependent variables. This means that all of the independent variables have an impact on Nigeria's development. Also, the value of Durbin Watson (2.1778), shows the absence of autocorrelation among residuals.

4.3. Implications of Result

The variables' long-term equilibrium was achieved via Johansen co-integration. This means that this estimation can be used to make long-term economic policy decisions. It also implies that gross capital formation and infrastructure policies, if maintained and directed to productive activity, can increase economic development. In the short run, gross capital formation has a positive relationship with economic development in Nigeria within the study period, which implies that capital formation has not contributed significantly to the development of the Nigerian economy as postulated by the Harold-Domar model of economic growth. This is owing to challenges in gathering statistics on private investment due to the inefficiency of data collection officers, record manipulation by Nigerian businessmen, and widespread public corruption. However, the positive and large influence of infrastructure on economic development demands that infrastructure is appropriately directed to Nigeria's economy. In the long run, gross capital formation and infrastructure both contributed positively to the economy's development during the study period.

5. Conclusion and Recommendation

This study examined how gross capital formation and infrastructure affect Nigerian economic development using the Vector Error Correction Mechanism. The study revealed that infrastructure has contributed more to Nigeria's economic development than gross capital formation. According to the study's findings and policy implications, government and private sectors should work together to foster capital investment in the economy. Also, agencies involved in gathering of statistical data should be more effective so as to capture all private investments in the country. Furthermore, gross capital formation should be efficiently channeled with a sizable amount accorded to infrastructural development

which in turn translates to economic development. Finally, government has to be proactive and make strong policies to block the loopholes and tackle the problem related to corruption in the economy.

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