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Capital Expenditure Dynamics And Infrastructural Growth Nexus: Evidence from An Oil-Dependent Economy

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Abstract
The role of infrastructure in promoting economic development has long been acknowledged in the economic literature. In Nigeria, the basic physical infrastructure deficit has been identified as a major drag in the country's prospects for development. One major source of infrastructure financing is government capital expenditure. Unfortunately, capital expenditure over the years has been characterized by wide fluctuations, with attendant consequences on the level of infrastructural development. Thus, this study seeks to investigate the nexus between capital expenditure dynamics and infrastructural performance within the Nigerian context, utilizing the Fully Modified Ordinary Least Square (FMOLS) and Error correction procedure (ECM) and data from 1981 to 2018. Findings suggest that both capital expenditure dynamics and inflation rate have a negative and statistically significant impact on the level of infrastructure while the impact of foreign aid on infrastructural development was positive and significant. Accordingly, we recommend among others, the need for a suitable macroeconomic and regulatory framework that will encourage active private sector participation to sustainably support infrastructure investment. The monetary authorities can complement such efforts by implementing policies that will guarantee at most single-digit inflation rate in the economy.

Dinamika Pengeluaran Modal dan Pertumbuhan Infrastruktur: Bukti dari Ekonomi yang bergantung pada Minyak

Abstrak
Peran infrastruktur dalam mendorong pembangunan ekonomi telah lama diakui dalam literatur ekonomi. Di Nigeria, defisit infrastruktur fisik dasar telah diidentifikasi sebagai hambatan utama dalam prospek pembangunan negara. Salah satu sumber utama pembiayaan infrastruktur adalah belanja modal pemerintah. Sayangnya, belanja modal selama bertahun-tahun telah ditandai dengan fluktuasi yang luas, dengan konsekuensi yang menyertainya pada tingkat pembangunan infrastruktur. Dengan demikian, penelitian ini berusaha untuk menyelidiki hubungan antara dinamika belanja modal dan kinerja infrastruktur dalam konteks Nigeria, menggunakan Fully Modified Ordinary Least Square (FMOLS) dan Error correction procedure (ECM) dan data dari 1981 hingga 2018. Temuan menunjukkan bahwa kedua model dinamika pengeluaran dan tingkat inflasi berpengaruh negatif dan signifikan secara statistik terhadap tingkat infrastruktur sedangkan dampak bantuan luar negeri terhadap pembangunan infrastruktur berpengaruh positif dan signifikan. Oleh karena itu, kami merekomendasikan antara lain, perlunya kerangka makroekonomi dan peraturan yang sesuai yang akan mendorong partisipasi aktif sektor swasta untuk mendukung investasi infrastruktur secara berkelanjutan. Otoritas moneter dapat melengkapi upaya tersebut dengan menerapkan kebijakan yang akan menjamin tingkat inflasi paling banyak satu digit dalam perekonomian.

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The role of infrastructure in fostering economic development has continued to attract attention in the literature since the seminal paper of Aschauer (1989). Infrastructure has been widely considered as an endogenous growth factor that can boost productivity, promote technology and information diffusion and engender human capital development (Roland-Holst, 2009).

Khandker and Samad (2018) associate infrastructural adequacy with a country's level of economic transformation gauged in terms of product diversification, trade expansion, coping with population growth, poverty alleviation, and environmental sustainability. Despite the developmental and growth-enhancing potentials of infrastructure, there is still a considerable gap in terms of the availability and quality of infrastructure in Nigeria. Poor infrastructure in the form of bad transport-related services (roads, rails, and ports), epileptic electricity supply, and unreliable telecommunication networks have almost become a stylized fact in Nigeria.

In many developing countries, including Nigeria, some private sectors may unwillingly provide the goods. Thus, the government should take responsibility for this since it deals with expenditure. On the other hand, the public sector in Nigeria hears the infrastructural facility provision costs. It means the government is the central role of infrastructure project financial provider. It is observable from the increased public capital expenditure level that receives financial support from crude oil exports or loans (Nurudeen & Usman, 2010; Akpokerere & Ighoroje, 2013; Onifade, Cevik, Erdogan, Asongu & Bekun, 2020). However, it is important to consider the susceptibility of crude oil to the international market vagaries.

This continuous rise in public capital expenditure in Nigeria has, however, been characterized by wide fluctuations. For instance, capital expenditure which stood at about N6.57 billion by 1981, declined to about N4.1billion by 1984, representing about 37.59 percent reduction. By 1999, the value of capital expenditure stood at N498.03 billion but declined to about N321.38 billion by 2002 before attaining the peak of N759.28 billion in 2007. It, however, rose to N874.70 billion in 2012, N1,108.39 billion in 2013, but fell to about N818.35 billion in 2015 before it attained a peak of N1,682.10billion in 2018 (see Table 1 in appendix).

In a similar vein, the value of gross fixed capital formation (a proxy for the level of infrastructure) has been characterized by significant variations over the years. For instance, in 1981, the value of gross fixed capital formation was N15789.67 billion but declined significantly to about N7121.28, before rising steadily to N7331.16, N7825.69, and N8385.97billion in 1990, 1993, and 1999, respectively. Furthermore, from a value of about N7559.73billion in 2002, it rose to about N9138.06 billion in 2010 and N10636.22billion in 2015 but declined marginally to about N10,569.60billion by the end of 2018.

Arguably, the fluctuations in the aforementioned variables could potentially have serious consequences on the growth trajectory of the Nigerian economy. Thus, much as changes in capital expenditure impact the economic infrastructure level, literature on the size and direction of such impact remains scanty, especially within the

Nigerian context. Therefore, this study try to close the gap.

This study broadens the literature insight about capital expenditure and infrastructural growth in three significant ways. Firstly, the “researcher recorded the variations in capital expenditure. They did it with the generalized autoregressive conditional heteroscedasticity (GARCH) procedure. This technique facilitates the creation of a volatility model as the previous behavior condition (Bollerslev, 1986). The step made the “researcher could ensure the reliability of making infrastructure investment policy.

Second, the study utilizes both the Fully Modified Ordinary Least Squares (FMOLS) and the Error Correction Modeling (ECM) techniques. While the former (FMOLS) produces reliable long-run estimates while accounting for serial correlation and system endogeneity resulting from cointegration, the latter accounts for the short-run dynamics. According to Pesaran (1997), such estimates (Fully Modified Ordinary Least Square and Error Correction Modelling) are of much practical and relevance in policy analysis and decision-making study.

Lastly, the time frame covered by this study (1981-2018) takes into consideration the various phases and measures that have been implemented thus far in a bid to strengthening the nation's infrastructural bases, including Nigeria's National Integrated Infrastructure Master Plan (NIMP) (2015) and Nigeria's 2017 Economic Recovery and Growth (ERG) among others. Thus, findings from this study will provide a better guide for policymaking and decision making.

LITERATURE REVIEW

The theoretical literature offers different perspectives on the macroeconomic effect of public expenditure. One strand of the literature in line with the Keynesian Economics School of thought which dates back to the aftermath of the Great Depression of the 1930s (Onifade, et al, 2020); posits that government spending, a key component of fiscal policy, can be used as a tool for short-run macroeconomic stabilization that is, for mitigating the size of business cycle fluctuations. However, the activities of the government can create distortions and exacerbate inflationary pressure.

The other issue on the government expenditure effects on economic growth is neoclassical growth tradition. This issue perceives growth rate determination by exogenous technological progress. Thus, the government expenditure only has level effects instead of steady-state growth rate effects (Devarajan, Swaroop & Zou, 1996). However, the endogenous growth theory predicts the GE affects the long-run growth rate. Barro (1990) found the possibility of the increased returns to scale by introducing GE as a public good that complements private-sector production.

On the empirical front, there is growing, albeit mixed, evidence on the growth effects of public expenditure and/or public spending on infrastructure using aggregated or disaggregated data (Kormendi & Meguire, 1985; Landau, 1986; Ram, 1986; Barro, 1990; Devarajan, Swaroop & Zou, 1996; Abu-Bader & Abu-Qarn, 2003; Nurudeen & Usman, 2010; Akpokerere & Ighoroje, 2013, Babatunde, 2018; Onifade et al, 2020). For instance, Ram (1986) found evidence of a positive and significant impact of government size on the economic growth of 115 countries from 1960-1970 and 1970-1980. On the contrary, Landau (1986) provides evidence that government capital expenditure has no growth accelerating effect, employing data for 65 countries spanning 1960-1980.

Similarly, Devarajan, Swaroop, and Zou (1996) utilizing data from 43 developing countries show that a misallocation of public spending in favor of capital expenditures can be unproductive. In particular, the study finds that the capital component of public spending (including a proxy for expenditure in economic infrastructure) is deleterious to economic growth. Contrarily, the empirical results of Bose, Haque, and Osborn (2007) using data for a sample of 30 developing countries over the 1970s and 1980s indicate that government capital expenditure exerts a positive and significant influence on economic growth. Specifically, the study reports that public expenditure on transport and communication infrastructure is significantly associated with economic growth, although the result was not robust to other specifications.

For country-specific analyses, the empirical results also vary considerably. Some studies (Okoro, 2013; Irmen and Kuehnel, 2009) document that government capital spending facilitates economic growth, others (Nurudeen and Usman, 2010; Akpokerere and Ighoroje, 2013) reveal that it is harmful to growth or, at best, irrelevant in explaining economic growth. Modebe et al (2012) find that the impact of capital expenditure on economic growth in Nigeria is negative and insignificant while Onakoya and Somole (2013) applying the three-stage least square (3SLS) estimation technique report that public capital expenditure fosters economic growth in Nigeria by enhancing private sector productivity.

Also, Babatunde (2018) lends credence to the view that government spending on infrastructure stimulates growth in Nigeria, and Africa in general (Fedderke, Perkins, and Luiz (2006). Javid (2019) obtains similar results for Pakistan applying the fully modified ordinary least squares (FMOLS) technique. Specifically, the author reports that investment in infrastructure is critical for growth at the aggregate and sectoral levels and concludes that the impact of public infrastructure investment on economic growth is larger than that of private infrastructure investment in Pakistan. Nonetheless, a recent study (Onifade et al, 2020) which employs the autoregressive distributed lag (ARDL) technique and annual time-series data for Nigeria spanning 1981 to 2017 finds no evidence to show that capital expenditure matters for long-run growth in Nigeria. The macroeconomic impact of various components of infrastructure has been analyzed with stock and quality measures of infrastructure. Although the evidence is mixed, the balance tilts in favor of a positive effect of infrastructure on economic growth. More precisely, Canning and Pedroni (1999) find that the stocks of infrastructure like telephone access, electricity, and paved roads matter for long-run growth. In the same vein, Roller and Waverman (2001) find evidence of significant growth effects of telecommunications infrastructure for 21 OECD countries. Similar results have been obtained by Sridhar and Sridhar (2007) for a sample of developing countries and Donou-Adonsou, Lim, and Mathey (2016) for sub-Saharan Africa. Furthermore, Calderon and Serven (2004) stressing the importance of infrastructural quality gives credence to the assertion that infrastructure is growth-enhancing.

Lenz, Skender & Mirkociv (2018) found a mixed result. They assessed the road and rail transport infrastructure effects on the economic growth of 11 Central and Eastern European Member States (C.E.M.S) from 1995 until 2016. They found a positive effect of road infrastructure on economic growth. However, they found railway structure negatively influenced economic growth.

The empirical literature on the capital expenditure-infrastructure nexus is remarkably thin. Dao (2008) in his study on factors that influence infrastructure development in a developing country context, however, highlights some components of public expenditure – the share of public spending on pensions and health in GDP, public savings as a percentage of GDP, and the share of civil service wages in government expenditure – that are linearly dependent with infrastructure indicators. Also, examining the determinants of infrastructure using panel data for 110 countries including Latin America, sub-Saharan Africa, and the Caribbean, Cerra, et al (2017) find that public finance plays a role in improving the stock of infrastructure.

Using data from Nigeria from 1970 to 2017, Okolo, Edeme and Emmanuel (2018) investigates whether capital expenditure matters for infrastructural development within the framework of the autoregressive distributed lag (ARDL) model. Their empirical results reveal that the effect of capital expenditure on infrastructure is insignificant in the short run but it is negative and statistically significant in the long run.

While our paper is similar in spirit to Okolo et al (2018), it, however, differs to the empirical approach adopted and our characterization of capital expenditure. Precisely, this study accounts for the variations in capital expenditure using the generalized autoregressive conditional heteroskedasticity (GARCH) technique.

METHOD

The study used annual time series data from 1981 to 2018. The “researcher obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin (2018) and the World Bank (World Development Indicators) (2019). Researcher chose the period of 1981-2018 since no available capital expenditure data older than 1981 and later than 2018. This research measured the volatility of capital expenditure with the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) procedure (Igbinedion, 2019). Bollerslev (1986) explains that GARCH creates a volatility model based on the previous behavior. This study used GARCH 1.1 as suggested by Akaike Information Criteria (AIC).

The theoretical foundation of this study is premised on separate but intuitively related theories, namely, the modernization theory (Tipps, 1973) which suggests that traditional societies will become wealthier and enjoy a better standard of living when they adopt more modern practices. These developments can take the form of new data technology and upgrading of traditional methods in infrastructures, such as transport, communication, and production activities. Thus, adopting such new technologies will make the transition from traditional society to a post-industrial society possible. The neoclassical growth models, on the other hand, posit that growth is determined mainly by exogenous technological progress. In this regard, government expenditure can only have level effects but does not affect the steady-state growth rate.

The endogenous growth theory predicts that in the determination of economic growth, government expenditure will significantly affect the long-run growth rate of a country. According to Barro (1990), by introducing government expenditure as a public good that complements private sector production, there is the possibility of achieving an increasing return to scale.

The "researcher specified a model with four covariates that included the capital expenditure, FGCE. The basis of thought about the model was the modification of the theoretical framework and Zhao & Kanamori's (2007) approach.

$$GFCF_t = \alpha_0 + \psi_1 FGCE_t + \psi_2 AID_t + \psi_3 INFL_t + \psi_4 TFCR_t + \varepsilon_t \quad (1)$$

$a_0, \Psi_1, \ldots, \Psi_4$, =The estimated parameters

ε_t = Gaussian white noise

GFCF =The gross fixed capital formation (a proxy for the level of infrastructure).

AID = The official development assistance;

INFL = The inflation rate,

TFCR = The total federally collected revenue,

FGCE = The federal government capital expenditure.

The techniques of analyzing the data were Fully Modified Ordinary Least Squares (FMOLS) and the Error Correction Modeling (ECM) approaches. The choice of the FMOLS as developed by Phillips and Hansen (1990) is to help cater for the possibility of long-run endogeneity in the variable, while the ECM as developed by Engle and Granger (1987) is to help cater for the short-run dynamics. This will be accompanied by some applicable preliminary and post-estimation tests for robustness purposes.

RESULTS AND DISCUSSION

Table 1 shows the variables and the corresponding characteristic summary. From the table, the net official development assistance (AID), federal government capital expenditure (FGCE) gross fixed capital formation (GFCF), inflation rate (INFL), and total federally collected revenue (TFCR) had their average values reported as 211.58, 423.64, 8498.09, 19.32 and 3279.63 respectively during the estimation period.

Also, all the variables were positively skewed in their behavior. Similarly, foreign aid, gross fixed capital formation, and inflation rate had excess Kurtosis values, a leptokurtic trend, federal government capital expenditure had moderate Kurtosis values suggestive of mesokurtic behavior. However, total federally collected revenue was platykurtic in its distribution. The Jarque-Bera statistic reveals that none of the variables were normally distributed. Table 1 reveals the descriptive statistics of the series.

Stationarity Test

In a bid to evaluate the stationarity properties of the relevant time series as well as establish their order of integration, the Augmented Dickey-Fuller (ADF) and Phillip-Person (PP) unit root tests were conducted, and the results are reported in Table 2a and 2b. The results from both ADF and PP unit root tests reject the null hypothesis of unit root for all variables at their first difference. This implies that all the variables are integrated of order one, that is, I (1). This supports our choice of the Error Correction Modeling (ECM) approach since the underlying theoretical requirement of the ECM technique is predicated on stationarity conditions (Granger and Newbold, 1977; Quah, 1994).

Table 1. Descriptive Tests Results

	AID	FGCE	GFCF	INFL	TFCR
Mean	211.58	423.64	8498.09	19.32	3279.63
Median	20.83	289.34	8111.33	12.55	1340.52
Maximum	1450.92	1682.10	15789.67	72.84	11116.85
Minimum	0.05	4.10	5668.87	5.38	10.51
Std. Dev.	354.59	437.85	1980.14	17.26	3761.07
Skewness	1.99	0.90	1.49	1.74	0.76
Kurtosis	6.23	3.01	6.33	4.84	2.11
Jarque-Bera	41.59	5.09	31.74	24.57	4.94
Probability	0.00	0.08	0.00	0.00	0.08
Observations	38	38	38	38	38

Source: Primary data processed (2020)

Table 2a. Stationary Test Results by Augmented Dickey-Fuller Test

Series	**t-Statistic**	**1% level**	**5% level**	**10% level**	**Order of Integration**	**Remark**
			Augmented Dickey-Fuller test			
AID	-5.99	-3.63	-2.95	-2.61	I(1)	Stationary
FGCED	-11.94	-3.63	-2.95	-2.61	I(1)	Stationary
GFCF	-4.88	-3.63	-2.95	-2.61	I(1)	Stationary
INFL	-6.25	-3.63	-2.95	-2.61	I(1)	Stationary
TFCR	-5.09	-3.63	-2.95	-2.61	I(1)	Stationary
ECM	-4.49	-3.63	-2.95	-2.61	I(0)	Stationary

Source: Primary data processed (2020)

Table 2b. Stationary Test Results by Phillips-Perron Test

Phillips-Perron Test						
AID	-8.81	-3.63	-2.95	-2.61	I(1)	Stationary
FGCED	-11.94	-3.63	-2.95	-2.61	I(1)	Stationary
GFCF	-5.28	-3.63	-2.95	-2.61	I(1)	Stationary
INFL	-5.59	-3.63	-2.95	-2.61	I(1)	Stationary
TFCR	-5.63	-3.63	-2.95	-2.61	I(1)	Stationary
ECM	-5.49	-3.62	-2.94	-2.61	I(0)	Stationary

Source: Primary data processed (2020)

Note: FGCED represents federal government capital expenditure dynamics

Cointegration Test

Essentially, the cointegration test is designed to ascertain the existence (or otherwise) of a long-run association among the variables in a regression model. In this regard, this study utilized the Johansen cointegration procedure. Two likelihood ratio tests, namely, max-Eigen and Trace test were utilized to determine the number of cointegrating vectors. From the results as contained in Table 3, Trace test statistic indicates 2 cointegrating equations each at 5% and 7% levels, while max-eigen test indicates 2 cointegrating equations at 5% and 1% levels each. These results indicate the existence of a stable long-run relationship among the series under consideration (Pesaran, 1997).

Table 3. Cointegration test result

Trend assumption: Linear deterministic trend
Series: AID FGCED GFCF INFL TFCR
Lags interval (in first differences): 1 to 2

Hypothesized No. of CE(s)	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	99.5	68.52	76.07
At most 1 *	49.52	47.21	54.46
At most 2	22.44	29.68	35.65
At most 3	9.41	15.41	20.04
At most 4	0	3.76	6.65
Hypothesized No. of CE(s)	**Max-Eigen Statistic**	**5 Percent Critical Value**	**1 Percent Critical Value**
None **	49.98	33.46	38.77
At most 1 *	27.08	27.07	32.24
At most 2	13.03	20.97	25.52
At most 3	9.41	14.07	18.63
At most 4	0	3.76	6.65
*(**) denotes rejection of the hypothesis at the 5%(1%) level			

Trace test indicates 2 cointegrating equation(s) at the 5% level
Trace test indicates 1 cointegrating equation(s) at the 1% level
Max-eigenvalue test indicates 2 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 1% level

Source: Primary data processed (2020)

The Fully Modified Least Squares (FMOLS)

This study assessed the effect of government capital expenditure dynamics on infrastructural growth in Nigeria utilizing the Fully Modified Ordinary Least Squares (FMOLS). In other words, having established the existence of a long-run relationship among the variables, we utilized the FMOLS to obtain the long-run estimates. The results shown in Table 4 below reveals that holding all other variables constant, GFCF takes on a positive value of 8479.89. The results also show that while TFCR and AID are positively related to GFCF, FGCED and INFL are inversely related to GFCF. In the former case (that is, TFCR and AID), a unit increase in either TFCR or AID will bring about an increase in GFCF. The reverse holds for FGCED or INFL where a unit rise in either FGCED or INFL will produce a decrease in GFCF. The results reveal (see Table 4) that all the variables are statistically significant. The p-values are lower than 0.01. However, the TFCR's p-value is higher than 0.05. Thus, TFCR is insignificant.

Table 4. Fully Modified Ordinary Least Squares (FMOLS)

Dependent Variable: GFCF

Method: Fully Modified Least Squares (FMOLS)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8479.89	109.15	77.69	0.00
FGCED	-1.61	0.33	-4.89	0.00
TFCR	0.03	0.02	1.73	0.09
AID	1.68	0.20	8.33	0.00
INFL	-19.55	3.30	-5.93	0.00
R-squared	0.32		Mean dependent var	8301.02
Adjusted R-squared	0.23		S.D. dependent var	1585.28
S.E. of regression	1390.46		Sum squared resid	61867685
Long-run variance	102215			

Source: Primary data processed (2020)

The Residual, Actual, and Fitted Observation

The illustration of the actual and fitted observations is close. It means the FMOLS model is robust. The results can be seen in Figure 1. It shows the actual and fitted lines. They are close to each other which shows the robustness of FMOLS model. In the next step, the "researcher used error correction procedure to estimate the short-run dynamics.

The "researcher also stimulated the actual gross fixed capital formation (GFCF) behaviors with changes in net official aid, inflation rate total federally collected revenue, and federal government capital expenditure dynamics to validate the findings. The "researcher used forecasting procedure with EViews application. The results showed the forecasted gross fixed capital formation (GFCF) for Nigeria remained inside the 2 standard error critical lines. It validates the

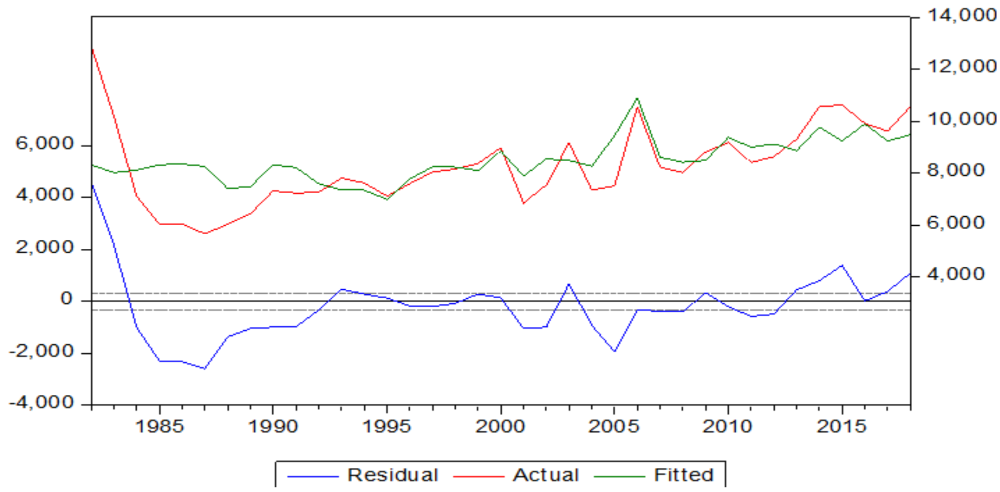


Figure 1. The Actual and Fitted Lines

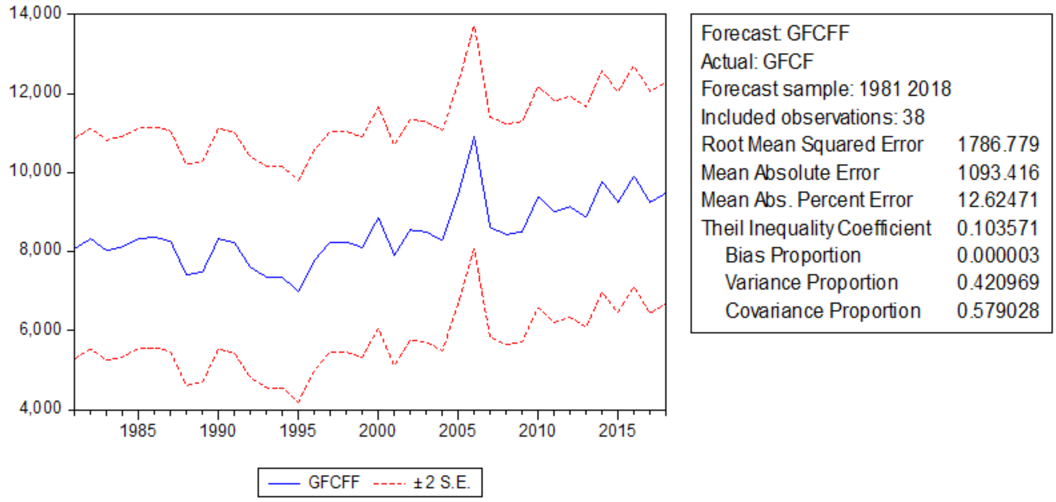


Figure 2. The Forecasted Gross Fixed Capital Formation (GFCF) Results

prediction accuracy and power. remained inside the 2 standard error critical lines. It validates the Nevertheless, the inequality index of 0.104 showed the relevance of the. Thus, judging from relevant econometric postulations, the nearer the value of this index to zero, the more accurate the forecast technique. The results can be seen in Figure 2.

Short-Run Analysis

The "researcher used the ECM (error correction term) procedure to obtained optimum lag of the model, based on estimate the short-run dynamics. The VAR lag selection criterion, is an optimal lag 1. LR, FPE, AIC, SC, and HQ criteria also suggest the lag 1 choice selection.

Table 5 provides the parsimonious short-term regression results. The parameter estimates along with the standard errors, t-values, and their corresponding critical values are reported in the table. The coefficient of the error correction term (ECM) is appropriately (that is, negatively) signed and is statistically significant at a 1 percent level of significance, with the speed

Table 5. ECM for Short Run Analysis (Highly Parsimonious)

Dependent Variable: D(GFCF)
Method: Least Squares
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-146.44	107.09	-1.37	0.18
D(GFCF(-1))	0.28	0.14	2.01	0.05
D(FGCED)	-1.71	0.58	-2.94	0.01
D(TFCR)	-0.05	0.10	-0.49	0.63
D(AID)	2.16	0.40	5.45	0.00
D(INFL)	-14.79	4.78	-3.09	0.00
ECM(-1)	-0.43	0.10	-4.41	0.00
R-squared	0.66	Mean dependent var		-64.56
Adjusted R-squared	0.59	S.D. dependent var		1207.36
S.E. of regression	771.26	Akaike info criterion		16.31
Sum squared resid	17250493	Schwarz criterion		16.61
Log-likelihood	-286.52	Hannan-Quinn criter		16.41
F-statistic	9.46	Durbin-Watson stat		1.82
Prob(F-statistic)	0.00	Wald F-statistic		29.27
Prob(Wald F-statistic)	0.00			

Source: Primary data processed (2020)

of convergence to equilibrium of about 43 percent. This result suggests that about a 43percent of the short-run disequilibrium in GFCF is corrected yearly. According to Pesaran (1997), such a rate of convergence to equilibrium is of practical significance in policymaking.

From Table 5, the parameter of federal government capital expenditure dynamics has a statistically significant negative relationship with infrastructural development in Nigeria. More specifically, the result suggests that a 1 percent change in federal government capital expenditure will translate to about a 1.71 percent decline in infrastructural development. This implies that temporal changes in the level of capital expenditure do impact significantly on infrastructural growth in the short run. This finding agrees with those of Onakoya, Tella, and Osoba (2012), Onakoya, Salisu, and Oseni (2012), Okpala and Olabisi (2013), and Okolo, Edeme, and Emmanuel (2018) but at variance with those of Balogun (2016) and Kolawole (2020). This inverse relationship may be partly explained by the yearly divergences between budgeted capital expenditure and actual spending (Okolo, Edeme, and Emmanuel, 2018) as well as corruption and poor level of accountability of funds (Onuorah and Appah 2012). This calls for the need for the institutionalization of relevant policies aimed at ensuring desiring effective budget implementation and accountability of funds.

However, the coefficient of total federally collected revenue (TFCR) was negative and statistically insignificant in its impact on infrastructural development in Nigeria within the period under consideration. Specifically, this result suggests that a 1 percent increase in TFCR will cause an infrastructural level decline by about 0.05 percent in Nigeria. This finding is not unexpected given the mono-product nature of the domestic economy, which depends largely on revenue from oil, and whose price is highly volatile and behind the control of local policymakers. Following Igbinedion (2019), this volatility in the price of Nigeria's major export earner calls for the need for relevant policies aimed at cushioning such negative shocks and, by extension, its attendant impact on infrastructural growth is the economy.

This inverse relationship between TFCR and infrastructure growth is in line with those of Nkanor and Udu (2016) but in contrast with studies, like Worlu and Emeka (2012), Nnanseh, and Akpan (2013), and Onwuka and Christian (2019). Furthermore, the inflation rate (INFL) was found to be negatively associated with the infrastructural growth level, as a 1 percent increase in INFL translates to about a 14.79percent decline in the level of infrastructure in Nigeria. This finding aligns with those of Nnenna (2016) and Magweva and Sibanda (2020). As observed by Igbinedion (2019), this inverse relationship within the Nigerian context is not strange given the fact that a high inflation rate, when accompanied by increased price volatility tends to raise the level of uncertainty about the profitability of long-term investment projects like infrastructure.

Residuals and Stability Diagnostics

In a bid to further validate the previous results, we conducted multicollinearity, serial correlation, heteroskedasticity, and normality tests. All variables' VIF scores are less than 10, showing no multicollinearity in the estimated FMOLS model (Table 6).

The serial correlation test shows the p-value is 0.28, higher than 0.05. It means no serial correlation in the estimated ECM model. The heteroscedasticity test shows the constant variance of the residues with a p-value of 0.54, higher than 0.05. It means the data do not have heteroscedasticity indication. Figure 3 shows error terms' normal distribution with a p-value of 0.54, higher than 0.05. This finding further confirms the robustness of the ECM model.

Heteroskedasticity Test

From the Table 7 below, the test of heteroscedasticity was carried out on the model, the result revealed that the variance of the residual is constant, since the (P-value = 0.54) is greater than 0.05. This implies that there is no evidence of heteroscedasticity in the residual.

Normality Test Result

The p-value of the error term is 0.54, higher than 0.05. It indicates normal distribution. Thus, the estimated ECM model is robust. The results of normality test can be seen in Figure 3.

Parameter Stability Tests

This research evaluated the stability properties of the error correction estimations with Brown, Durbin & Evans'

Table 6. Multicollinearity Test

Variance Inflation Factors
Sample: 1981–2018
Included observations: 36
Null Hypothesis: No multicollinearity

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	11467.28	1.460614	NA
D(GFCF(-1))	0.02	3.23	2.98
D(FGCED)	0.34	1.73	1.42
D(TFCR)	0.01	1.66	1.61
D(AID)	0.16	2.92	2.82
D(INFL)	22.86	1.64	1.60
ECM(-1)	0.01	2.37	2.37

Source: Primary data processed (2020)

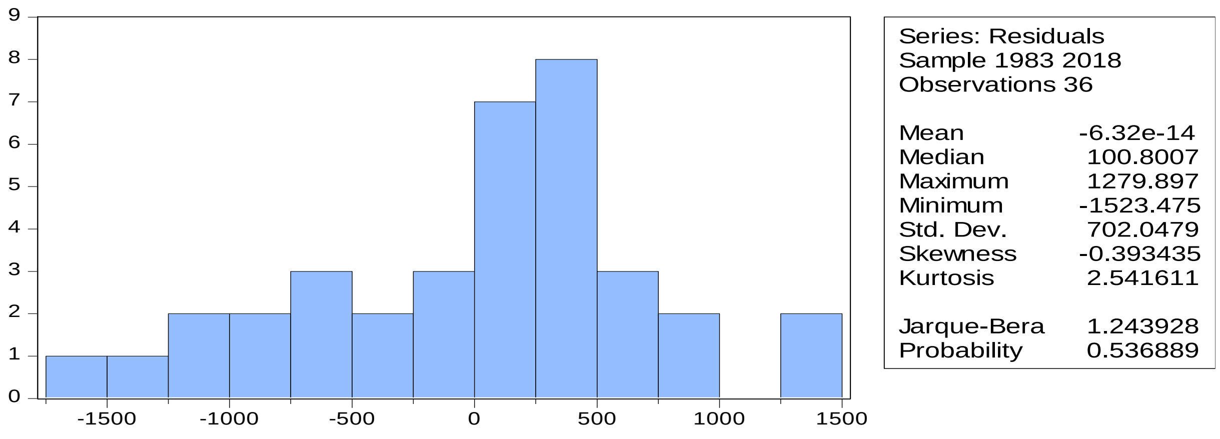
Table 7. Heteroskedasticity Test

Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.32	Prob. F(2,27)	0.28
Obs*R-squared	3.21	Prob. Chi-Square(2)	0.20

Source: Primary data processed (2020)

Figure 3. Normality Test Results



Source: Primary data processed (2020)

(1975) approach. The results proved no coefficient instability. The cumulative sum of residual plot, CUSUM, and the cumulative sum of squares of recursive residuals, CUSUMSq, is between 5% confidence interval. The blue line is located between the red lines, 5% significance, indicating the model's stability. It means the model is reliable to predict or forecast. The detailed results can be senn in the Figure 4a and Figure 4b below.

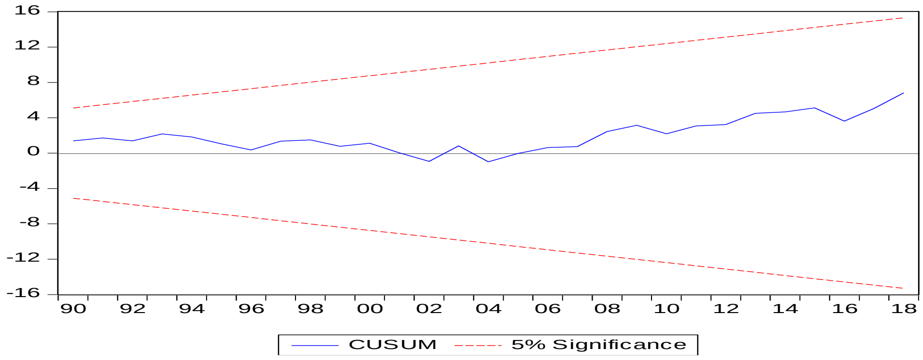


Figure 4a. Cumulative Sum of Recursive Residual (CUSUM)

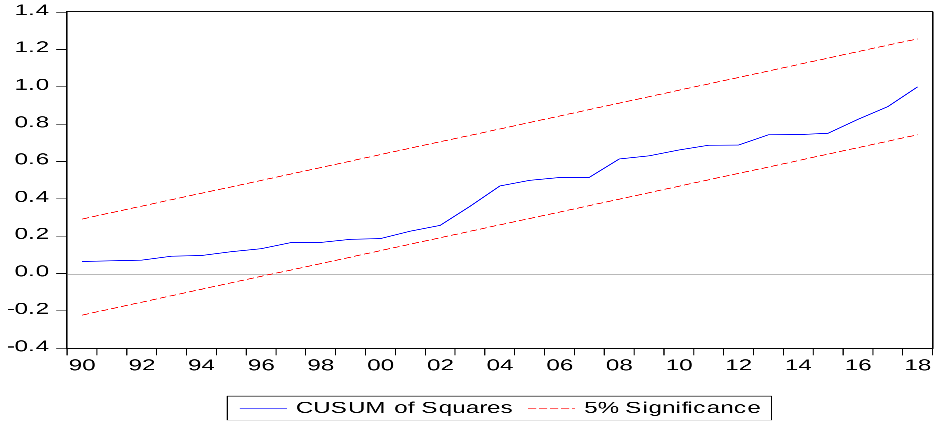


Figure 4b. Cumulative Sum of Square Recursive Residual (CUSUMSq)

Pairwise Granger Causality Test

The "researcher conducted the pairwise Granger causality test to find whether the variables could predict or not. Table 8 shows that in the short run, net official development assistance (AID), total federally collected revenue (TFCR), and federal government capital expenditure dynamics Granger cause gross fixed capital formation (GFCF), a proxy for infrastructural development in Nigeria.

CONCLUSION

Utilizing the Error Correction (ECM) procedure and the Fully Modified Ordinary Least Squares methodology (FMOLS), this study examined the impact of capital expenditure dynamics on infrastructural performance within the Nigeria context for the period 1981 to 2018. The results reveal in part that, in both the short-run and long-run federal government expenditure dynamics was negatively (but significantly) related to infrastructural performance in Nigeria – a development that has partly been attributed to the increasing discrepancies between, budgeted capital expenditure and actual spending, endemic level of corruption and weak accountability in the execution of capital projects, among

Table 7. Pairwise Granger Causality Tests

Sample: 1981- 2018
Lags: 1

Null Hypothesis	Obs	F-Statistic	Prob.
FGCED does not predict AID	37	0.58	0.45
AID does not predict FGCED		7.27	0.01
GFCF does not predict AID	37	0.13	0.72
AID does not predict GFCF		**4.20**	**0.05**
INFL does not predict AID	37	0.12	0.74
AID does not predict INFL		1.22	0.28
TFCR does not predict AID	37	3.63	0.07
AID does not predict TFCR		1.57	0.22
GFCF does not predict FGCED	37	0.19	0.67
FGCED does not predict GFCF		**5.87**	**0.02**
INFL does not predict FGCED	37	0.01	0.92
FGCED does not predict INFL		0.51	0.48
TFCR does not predict FGCED	37	0.81	0.38
FGCED does not predict TFCR		0.76	0.39
INFL does not predict GFCF	**37**	**0.06**	**0.81**
GFCF does not predict INFL		0.88	0.35
TFCR does not predict GFCF	**37**	**11.78**	**0.00**
GFCF does not predict TFCR		0.00	0.99
TFCR does not predict INFL	37	1.51	0.23
INFL does not predict TFCR		0.18	0.68

Source: Primary data processed (2020)

others. Also, inflation was found to be negatively related to infrastructural performance, as it tends to raise the level of uncertainty associated with the profitability of long-term capital projects.

Foreign aid has a positive and statistically significant impact on infrastructural performance within the period under consideration. However, the total federally collected revenue (TFCR) was statistically insignificant in both the short-term and long-run estimations.

Given the foregoing findings, we make the following specific policy recommendations. First, given the fact that wide fluctuations in government expenditure have significant negative impacts on infrastructural performance in both the short and long run, there is an urgent need to cushion such negative effects. This can be achieved by raising the capital expenditure profile of annual budgetary allocations as well as ensuring the effective utilization of such funds. This should be complemented by putting in place a suitable macroeconomic and regulatory framework that encourages private sector participation to sustainably support infrastructure investment and curb corruption and mismanagement of funds.

Second, the monetary authorities should implement policies aimed at enthroning single-digit inflation rates. Such policies will help boost infrastructure investment, especially from the private sector fund, by extension, the economic growth trajectory of the nation.

Third, since foreign aid has a positive impact on infrastructure performance, within the period under consideration there is the need to put in place relevant policies aimed at attracting more of such aid flows into the economy, especially those aids that are tied to infrastructure. Such aid, when available in the right quantity and quality will help boost the level of infrastructure stock accumulation in the economy and by extension, promote economic transformation and alleviate poverty.

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Appendix:

Table 1. Federal Government Capital Expenditure Dynamics and Infrastructural Development in Nigeria (1981-2018)

Year	Net official development assistance and official aid received (constant 2015 ₦'Billion) (World Bank)	Inflation Rate (%) (CBN)	Gross fixed capital formation (₦'Billion)(World Bank)	Total Federally Collected Revenue (₦'Billion) (CBN)	Federal Government Capital Expenditure(₦'Billion) (CBN)	Federal Government Capital Expenditure Dynamics (Author's Derivation)
Year	**AID**	**INFL**	**GFCF**	**TFCR**	**FGCE**	**FGCED**
1981	0.06	20.81	15789.67	13.29	6.57	-3.59
1982	0.05	7.7	12893.8	11.43	6.42	-0.15
1983	0.08	23.21	10198.26	10.51	4.89	-1.53
1984	0.06	17.82	7121.279	11.25	4.1	-0.79
1985	0.07	7.44	6032.258	15.05	5.46	1.36
1986	0.22	5.72	6045.457	12.6	8.53	3.07
1987	0.43	11.29	5668.868	25.38	6.37	-2.16
1988	0.73	54.51	6047.752	27.6	8.34	1.97
1989	3.54	50.47	6441.9	53.87	15.03	6.69
1990	2.79	7.36	7331.156	98.1	24.05	9.02
1991	3.43	13.01	7240.294	100.99	28.34	4.29
1992	5.63	44.59	7277.432	190.45	39.76	11.42
1993	8.64	57.17	7825.686	192.77	54.5	14.74
1994	5.46	57.03	7633.267	201.91	70.92	16.42
1995	5.18	72.84	7126.178	459.99	121.14	50.22
1996	4.96	29.27	7610.325	523.6	212.93	91.79
1997	5.58	8.53	8055.208	582.81	269.65	56.72
1998	5.79	10	8167.453	463.61	309.02	39.37
1999	17.97	6.62	8385.965	949.19	498.03	189.01
2000	23.68	6.93	8996.914	1,906.16	239.45	-258.58
2001	26.02	18.87	6860.444	2,231.60	438.7	199.25
2002	48.14	12.88	7559.731	1,731.84	321.38	-117.32
2003	48.29	14.03	9178.168	2,575.10	241.69	-79.69
2004	83.85	15	7348.339	3,920.50	351.25	109.56
2005	842.11	17.86	7520.474	5,547.50	519.47	168.22
2006	1450.92	8.24	10557.89	5,965.10	552.39	32.92
2007	230.31	5.38	8246.212	5,727.51	759.28	206.89
2008	146.33	11.58	8031.723	7,866.60	960.89	201.61
2009	237.81	11.54	8828.807	4,844.59	1,152.80	191.91
2010	299.39	13.72	9183.059	7,303.67	883.87	-268.93
2011	257.18	10.84	8425.762	11,116.85	918.55	34.68
2012	281	12.22	8640.765	10,654.75	874.7	-43.85
2013	366.4	8.48	9320.347	9,759.79	1,108.39	233.69
2014	357.18	8.06	10571.74	10,068.85	783.12	-325.27
2015	462.14	9.02	10636.22	6,912.50	818.35	35.23
2016	746.88	15.7	9927.256	5,679.03	634.79	-183.56
2017	1011.69	16.5	9631.696	7,317.70	1,163.20	528.41
2018	1050.24	12.10	10,569.60	9,551.80	1,682.10	518.9