Vedecký článok/ Scientific article
Doručené/Received: 20. 08. 2024
Akceptované/Accepted: 7. 10. 2024
https://doi.org/10.24040/eas.2024.25.2.5-24

A disaggregated ARDL analysis of capital formation on economic growth in Nigeria: Evidence from the endogenous growth model

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Abstract: This study has investigated the disaggregated impact of capital formation on economic growth in Nigeria over the periods of 1990 to 2021 sourcing its data from the 2022 Central Bank of Nigeria Statistical Bulletin and 2023 World Development Indicators. Specifically, it examined how, and to what extent, gross capital formation, government recurrent expenditures on education and health, foreign direct investment, gross domestic savings, and domestic credit to private sectors have impacted economic growth in Nigeria. It used the Phillip-Perron, Kwiatkowski-Phillips-Schmidt-Shin, and the augmented Dickey-Fuller unit root test to ascertain the order of integration among the series. Consequently, through the Auto-Regressive Distributed Lag bound testing technique, the study found that in the long run, the disaggregated physical and human capital formation had a significant positive influence on economic growth. In the short-run, however, government recurrent expenditures on education, foreign direct investment, and domestic credit to private sectors had a significant impact on economic growth while other variables did not significantly cause economic growth. Thus, in conclusion, the study suggests policy recommendations to boost human capital through education, health, and credit access, while addressing high interest rates.

Key words: *ARDL. Capital formation. Endogenous growth model.*

JEL Classification: C22. E22. O40.

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Introduction

Economic growth remains a critical goal for developing countries, particularly Nigeria, because it is instrumental in enhancing living standards, alleviating poverty, generating employment, and promoting social stability. It reduces the incidence of crime and social unrest, enhances a country's political stability and governance, improves infrastructure, and fosters a stable and prosperous society. The ripple effects of economic growth can lead to a more equitable distribution of wealth, better governance, and a stronger, more resilient nation poised for future challenges and opportunities (World Bank, 2020). Nigeria's economic growth has been volatile, influenced by fluctuations in global oil prices, political instability, and macroeconomic challenges. While the country experienced rapid growth in the early 2000s, driven by high oil prices, growth rates have slowed in recent years due to falling oil prices, exchange rate instability, and security challenges. The COVID-19 pandemic further exacerbated these issues, leading to a recession in 2020 (International Monetary Fund [IMF], 2021).

Capital formation through physical and human capital is important in achieving economic growth. Capital formation involves accumulating physical assets and human effectiveness in labour which enhances an economy's productive capacity. This includes investments in infrastructure, machinery, buildings, and technology. Capital formation is essential for economic growth, as it increases production potential, improves efficiency, and stimulates innovation (Khan *et al.*, 2021). In Nigeria, capital formation has faced several challenges, including inadequate infrastructure, limited access to finance, inefficiency in human investment, and low domestic savings rates. Despite these challenges, significant investments in infrastructure projects have been made, particularly in the telecommunications and energy sectors. However, the impact of these investments on economic growth has been mixed due to issues such as poor project execution, weak institutional quality, and maintenance deficits (Adenikinju & Olofin, 2000).

The Nigerian government has implemented various policies to promote capital formation, including public-private partnerships (PPPs), special economic zones, and incentives for foreign direct investment. Initiatives such as the Economic Recovery and Growth Plan (ERGP) and the National Integrated Infrastructure Master Plan (NIIMP) aim to address infrastructure deficits and attract investment. However, the effectiveness of these policies has been limited by bureaucratic bottlenecks, policy inconsistencies, and security concerns (Federal Government of Nigeria, 2017). On the other hand, human capital encompasses the skills, knowledge, and

experience individuals contribute to their productivity and economic value (Kuznetsova *et al.*, 2019). Therefore, investment in human capital through education and healthcare is crucial for economic growth as it enhances workforce capabilities, fosters innovation, and increases productivity. Nigeria faces significant challenges in human capital development, including inadequate funding for education and healthcare, poor quality of education, and high rates of unemployment and underemployment. Although school enrollment rates have improved, quality issues persist, with many graduates lacking the skills needed in the labour market.

Studies abound on the relationship among capital formation, human capital, and economic growth that covers divergent periods, countries, and regions, which invariably have produced varying results. To start with, Onyinye, Idenyi, and Ifeyinwa (2017) examined the impact of capital formation on Nigeria‘s economic growth using a co-integration and Vector Error Correction (VEC) model and found a stable long-term relationship, with government capital expenditure negatively correlated with gross domestic product. Also, amongst other factors that can boost economic growth is the domestic credit to the private sector, and in this fact, Amoo, Eboreime, Adamu, and Belonwu (2017) examined the impact of local conditions and policy environment affecting Nigeria’s credit absorptive capacity from 1993 to 2013 revealing that that credit enhances growth, even with low trade openness, monetary policy, investment climate, and infrastructure. Then affirmatively concluding that the domestic economy’s absorptive capacity for credit is estimated at 29%.

Ogunniyi (2018) examined the impact of human capital formation on Nigeria’s economic growth from 1981 to 2014, using 34-year data revealing a long-term dynamic relationship that suggests that policymakers should increase education sector expenditure and healthcare personnel development. Also, adequate distribution of health facilities and adequate distribution of facilities are crucial for economic growth. In this vein, Ayeni and Omobude (2018) found that educational expenditure is inconsistent with sectoral output, but recurrent expenditure significantly impacts growth on Nigeria’s economic growth then recommending institutional transformation in policy formulation, implementation, monitoring, and funding for long-term economic growth. Kuznetsova *et al.* (2019) analysed the methodological approaches to the formation of human capital in the context of the digital economy. The study utilised the monographic and system analysis methods and found that the agricultural industry, which is labour-intensive and reliant on technological advancements, has significant untapped potential that generalised analysed urbanisation modeling analysis through enhanced human capital.

Akinlo and Oyeleke (2020) explored the relationship between human capital and economic growth and whether the relationship is influenced by the level of economic development in 36

sub-Saharan African countries from 1986 to 2018 using the dynamic generalised method of moments (GMM) and static estimations, the data covered the period from 1986 to 2018. The findings revealed that human capital significantly contributes to economic growth in sub-Saharan Africa. Pasara and Garidzirai (2020) explored the causal relationships between gross capital formation, unemployment, and economic growth in South Africa from 1980 to 2018 using the Vector Auto-regressive (VAR) model and found a positive long-term relationship between gross capital formation and economic growth, suggesting that increases in gross capital formation are associated with improvements in economic growth over an extended period. Also, Topcu (2020) analysed the impact of natural resources, energy consumption, and gross capital formation on economic growth from 1980 to 2018 across 124 countries classified by income levels using the Panel Vector Auto-regressive (PVAR) approach, revealing that gross capital formation, urbanisation, and energy consumption positively impact economic growth.

As such, to also assess the impact of export earnings on capital formation in Nigeria, Ozuzu and Ewubare (2020) revealed that gross capital formation showed a long-term relationship with export earnings. Olopade *et al.* (2020) examined the relationship between technology, human capital, and economic growth and their implications for a knowledge-based economy in Nigeria, sourcing their data from the Federal Office of Statistics and the Central Bank of Nigeria Statistical Bulletin from 1981 to 2017. Then, they revealed through the causality test a unidirectional relationship between gross capital formation and real output and that human capital formation and real output growth do not cause each other. However, there is a bidirectional causality between human capital and capital formation. Yasmeen *et al.* (2021) explored the relationship between natural resources, gross capital formation, and energy consumption with economic growth employing structural equation modelling (SEM) to analyse the relationships between the variables with quarterly data from 1990Q1 to 2018Q4 and found a negative relationship between natural resources and economic growth, and the influence of gross capital formation on economic growth is found to be insignificant. Kobayakawa (2021) investigated the relationship between the carbon footprint of capital formation and economic growth across different countries, employing a multi-regional input-output (MRIO) model to analyse the carbon footprint, and found that developing countries investing heavily in carbon-intensive capital formation achieve faster economic growth.

Specifically, Abraham and Adama (2021) examined the impact of capital formation on domestic savings in Nigeria, using trend analysis and advanced econometrics tests finding a long-term significant relationship between capital formation by banks and non-bank financial institutions and economic growth. However, the study showed that there exists a negative non-

significant relationship between domestic savings and capital formation then recommended to policymakers in Nigeria to encourage capital inflows and provide a conducive environment for gross fixed capital formation, reduce speculative businesses, and invest in real economy sectors. Keji (2021) investigated the relationship between human capital and economic growth in Nigeria from 1981 to 2017 employing the Auto-regressive distributed lag (ARDL) revealing a significant long-term impact of human capital on economic growth in Nigeria, highlighting the need for increased budgetary allocations to education and health to enhance human capital development and sustain economic growth. Khan *et al.* (2021) investigated the causal relationship between energy consumption, capital formation, and economic growth in Pakistan through the Johansen cointegration test and VEC methods, sourcing the data from the World Bank's World Development Indicators from 1990 to 2018. The findings revealed that the variables are cointegrated, indicating a long-run relationship and then suggesting a bidirectional causality between energy consumption and economic growth.

To also, juxtapose the effects of foreign direct investment, Oyegoke and Aras (2021) revealed that it is a crucial source of finance, capital formation, technology transfer, capital formation, and trade among countries, particularly in developing countries like Nigeria likewise averting that the country is the first host economy of foreign direct investment in sub-Saharan Africa region and the third in the continent. However, the impact of foreign direct investment on economic growth is controversial which prompts the investigation of the effects of foreign direct investment on economic growth showing a positive significant effect on the Nigerian economic growth. Ameer et al. (2022) found that public capital positively influences foreign direct investment inflows, while private capital negatively impacts these inflows using the Cross-Sectional Autoregressive Distributed Lags (CS-ARDL) approach. Therefore, to this end, these empirical studies showed that human capital and capital formation significantly contribute to economic growth across regions, though their impacts vary but their interplay is crucial for sustainable development.

Despite these efforts, healthcare outcomes are also suboptimal, with high maternal and infant mortality rates, limited access to quality healthcare, and a shortage of medical professionals (Okebukola, 2005). The Nigerian government has implemented various policies to improve human capital development, including the Universal Basic Education (UBE) programme, the National Health Insurance Scheme (NHIS), and the Youth Employment and Social Support Operation (YESSO). Despite these efforts, challenges such as inadequate funding, poor implementation, and systemic inefficiencies continue to hinder progress (Federal Ministry of Education, 2018). The proper alignment of physical and human capital formation

and economic growth can potentially transmute the economy to the state of Eldorado. Hence, human capital, encompassing education, health, and skills, and physical capital through gross fixed capital are crucial for enhancing productivity and achieving sustainable economic growth.

The reality at the moment, however, suggests that Nigeria, despite its abundant resources, faces challenges such as inadequate investment in human capital, which has led to suboptimal economic performance (Keji, 2021). It is against this background, coupled with other associated factors, that the study is motivated to explore the impact of disaggregated capital formation on economic growth in Nigeria with the sole interest of testing the hypothesis that disaggregated capital formation does not have a significant effect on economic growth. As such, this makes the present study necessary to be visited, given that it demands an outstanding recommendation for harmonizing the disaggregated capital formation on economic growth in Nigeria between 1990 and 2021. Therefore, this study is divided into three other sections: theoretical framework, material and methods, results and discussions, and conclusion.

1. Theoretical framework

This study, anchored on the endogenous growth theory developed by Romer (1990), posits that economic growth is driven by factors intrinsic to the economy, notably human capital accumulation and technological innovation through physical capital. The theory emphasizes the pivotal role of human capital in driving technological progress and innovation. Human capital, encompassing education, skills, and health, is seen as a fundamental input in the production of new ideas and technologies, which are critical for sustained economic growth. Endogenous growth theory further elaborates on the role of capital formation, incorporating elements such as human capital, innovation, and knowledge into the growth process. It suggests that investments in education, research and development (R&D), and technology are essential for maintaining long-term economic growth.

This theory underscores the importance of both physical capital and intangible assets in driving economic development. Unlike physical capital, which may face diminishing returns, human capital and knowledge can generate increasing returns due to their non-rival and non-excludable nature. Akinlo and Oyeleke (2020). Khan *et al.* (2021) emphasize that, in addition to human capital, factors like innovation and knowledge are integral to capital formation and economic growth. Investments in technology and education are not merely supportive but essential components of the growth process. This holistic view suggests that sustainable economic growth requires a comprehensive approach that values both tangible and intangible assets. In a nutshell, endogenous growth theory offers a robust framework for understanding

how internal economic factors, particularly human capital and technological innovation, drive long-term growth. To juxtapose the study, the endogenous growth model is specified in (1),

$$Y_t = A_t {K_t}^{\varphi} {L_t}^{\gamma} \tag{1}$$

Y_t is the economic output at time t, A_t and K_t are knowledge and physical capital, L_t is the labour while φ and γ elasticity outputs of physical capital and labour respectively. The AK model is the simplest endogenous model, through capital formation, external saving, and growth rates. It uses a single parameter to simulate knowledge advancement and assumes no diminishing returns to scale, supported by positive economic spillovers, physical formation, and human formation upward spirals. This is expressed in (2) where $\varphi = 1$, and $\gamma = \varphi - 1$,

$$Y_t = A_t {K_t}^{1} {L_t}^{1-1} \tag{2}$$

$$Y_t = A_t K_t \tag{3}$$

(3) expresses how the disaggregated capital formation of human capital through knowledge denoted as A_t and physical capital denoted as K_t determines economic growth at any time lag. To this end, (3) guides the framework of the study to give empirical evidence in Nigeria.

2. Material and methods

The study adopts the *ex post facto* research design as a result of investigating the nature of the paper empirically. As such, this study gives a modification in the adoption of variables used in Ogunniyi (2018), Abraham and Adama (2021), and Keji (2021) specified in (4) where PC_t is physical capital formation, and HC_t is human capital formation.

$$GDP_t = f(PC_t, HC_t) \tag{4}$$

$$GDP_t = f\ (GCFR_t, LGEDU_t, LGHE_t, SAV_t, FDI_t, DCP_t) \tag{5}$$

(5) expresses the linear form of the disaggregated physical and human capital formation in Nigeria. As such, the econometric model is then specified in (6) from the linear functional form as specified in (5),

$$GDP_t = \delta_0 + \delta_1 GCFR_t + \delta_2 LGEDU_t + \delta_3 LGHE_t + \delta_4 SAV_t + \delta_5 FDI_t + \delta_6 DCP_t + \eta_t \tag{6}$$

Where $\delta_0 - \delta_5$ are vector parameters of the estimate, and η_t is the stochastic error term of the model. Thus, to investigate the disaggregated effect of capital formation on economic

growth in Nigeria, the study conducted some preliminary tests, which varied from stylized facts, descriptive statistics, a correlation matrix, and a summary of the variables as a unit root test.

This preliminary test explains the behaviour of the series from 1990 to 2021. The dependent variable for the study is economic growth, while capital formation was a proxy using physical capital formation and human capital formation. The annual percentage growth of Nigeria's gross capital formation was used as a proxy for physical capital formation, while the log of recurrent government expenditures on health and education was used as a proxy for human capital formation. Therefore, to critically examine the effect of capital formation on economic growth, there is a direct and significant link to the nation's annual gross domestic savings, foreign direct investment, and also the rate to which domestic credit is being accessed by the private sector, prompting the choice of the model's control variable. Sources, proxy, and justification of the variables are depicted in Table 1.

Table 1 Source, Proxy, and Justification of the Variables

Name of variables	**Proxy**	**Justification**	**Source**	**Expected impact**
Economic growth	Gross domestic product (annual %)	Ogunniyi (2018); Keji (2021)	2023 World Development Indicators	Positive
Physical capital formation	Gross capital formation (annual % growth)	Ogunniyi (2018); Keji (2021)	2023 World Development Indicators	Positive
Human capital formation	Government recurrent expenditure on education	Ogunniyi (2018); Keji (2021)	2022 Central Bank of Nigeria Statistical Bulletin	Positive
	Government recurrent expenditure on health	Ogunniyi (2018); Keji (2021)	2022 Central Bank of Nigeria Statistical Bulletin	Positive
Control variable	Gross domestic savings (% of GDP)	Abraham and Adama (2021)	2023 World Development Indicators	Positive
	Foreign direct investment, net inflows (% of GDP)	Oyegoke and Aras (2021)	2023 World Development Indicators	Positive
	Domestic credit to private sector (% of GDP)	Amoo, Eboreime, Adamu, and Belonwu (2017)	2023 World Development Indicators	Positive

Source: Authors' computation.

3. Results and discussion

This section presents the study's results and analysis, including pre-estimation techniques like descriptive statistics, correlation matrix, and unit root tests. The study used the Phillip-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests to check the order of stationary series at trend and, trend and intercept. The PP and KPSS unit root test was chosen for its general form of heteroscedasticity, while the augmented Dickey-Fuller (ADF) and the unit root test were conducted to ensure consistency.

3.1. Pre-estimation techniques

3.1.1. Descriptive statistics

Table 2 revealed the descriptive statistics of capital formation and economic growth, showing that the highest economic growth in Nigeria is 15.3%, with a mean threshold of 4.3 average between 1990 and 2021. The gross capital formation has its highest rate at 40.7% with a 2.3% mean value, and in the same vein, the recurrent expenditure on education and health by the Nigerian government, respectively, has a peak expenditure of ₦646.75 billion, and ₦423.33 billion naira is spent averagely on its economy to improve human capital to drive economic growth. Also, the results further show that, on average, the Nigerian government has invested ₦189.7 billion and ₦114.9 billion in human capital formation. Based on this, the economic implication is that, on average, the Nigerian government invests more in human capital formation to trigger economic growth in the country. Likewise, the nation's capital investment through domestic savings and foreign direct investment on average is 34.7% and 1.62% between 1990 and 2021, while access to domestic credit in the private sector grows on average by 10.3%. These mean results of the descriptive statistics show that the mean of all the series is positive, indicating that its economic significance is that the variables are increasing annually, lying between the minimum and maximum rates. Besides, the descriptive results show that the gross capital formation and the recurrent government expenditures on education and health, respectively, have their standard deviations dispersed higher than their mean, while other series are relatively deviating from their mean values. This dispersion implies that credit to the private sector is not easily accessed due to a higher interest rate, which could retard the rate of capital growth.

Also, gross domestic product indicates that the available capital, *viz.*, savings and foreign direct investment in the country, is not sufficient to increase or improve the growth of the nation compared to other nations. On the other hand, gross domestic product, formation of capital, savings, direct investment from abroad, access to domestic credit, and recurrent government

expenditures on education and health, respectively, are positively skewed. In terms of the series relationship through its central moment and standard deviation to determine the symmetric distribution, it was revealed that the gross domestic product, gross capital formation, foreign direct investment, and domestic credit to the private sector are leptokurtic, that is, the series is relatively highly peaked, while the savings and recurrent government expenditures on education and health, respectively, are platykurtic at 2.22, 2.62, and 2.89, respectively, that is, the series is relatively flat-topped.

Table 2 Descriptive Statistics

Variables	GDP_t	$GCFR_t$	$GEDU_t$	GHE_t	SAV_t	FDI_t	DCP_t
Max.	15.3291	40.7438	646.7475	423.3298	64.2114	5.7908	19.6256
Min.	-2.0351	-22.7928	0.2912	0.1501	13.0804	0.1838	4.95752
Mean	4.3201	2.3097	189.7057	114.9371	34.79601	1.6263	10.2744
Std. Dev.	4.0171	12.2472	200.9563	129.6805	13.7998	1.1989	3.5399
Skewness	0.4354	0.4006	0.9171	1.0079	0.3268	1.8654	0.8211
Kurtosis	3.2865	5.0119	2.6240	2.8293	2.2235	6.8827	3.3527
Obs.	32	32	32	32	32	32	32

Source: Authors' computation.

3.1.2. Correlation matrix

Table 3 shows the correlation between the variables, indicating that gross capital formation, recurrent government expenditures on education and health, savings, and credit access to the private sector have a positive but insignificant correlation on economic growth, except for the rate of foreign direct investment, which has a negative and insignificant correlation on economic growth. Despite this positive correlation, the results indicate a weak correlation with the economic growth rate of Nigeria, implying that gross capital formation has a 21.6% relationship with economic growth. This means that with only physical capital formation in Nigeria, its economic growth will grow at a weaker rate. Also, in the same direction, recurrent government expenditures on education and health relate to economic growth by 3.9% and 3.3%, respectively, while savings and foreign direct investment relate to economic growth by 1.9% and 7.1%, respectively. These weaker relationships depict that the nation cannot increase economic growth. This is supported by the negative relationship between foreign direct investment and economic growth of 5.2%. The economic implication of this result is that the rate at which capital formation in Nigeria increases economic growth is relatively lower due to

her physical and human capital formation, while foreign direct investment reduces the pace at which economic growth is being increased in Nigeria.

Table 3 Correlation Matrix

Variables	GDP_t	$GCFR_t$	$LGEDU_t$	$LGHE_t$	SAV_t	FDI_t	DCP_t
GDP_t	1.0000 [----]						
$GCFR_t$	0.2155 [1.209]	1.0000 [----]					
$LGEDU_t$	0.0395 [0.217]	-0.0209 [-0.114]	1.0000 [----]				
$LGHE_t$	0.0339 [0.186]	-0.0436 [-0.239]	0.9924* [44.349]	1.0000 [----]			
SAV_t	0.0191 [0.104]	0.1629 [0.904]	-0.8338* [-8.273]	-0.8587* [-9.178]	1.0000 [----]		
FDI_t	-0.0515 [-0.282]	0.0329 [0.180]	-0.3059 [-1.759]	-0.2942 [-1.686]	0.3117 [1.797]	1.0000 [----]	
DCP_t	0.0708 [0.388]	-0.1627 [0.903]	0.6588* [4.797]	0.6910* [5.237]	-0.7358* [-5.952]	-0.0470 [-0.258]	1.0000 [----]

** indicates a significant value at 5%, and [] implies the t-statistic value.*

Source: Authors' computation.

3.1.3. The stationarity test

Therefore, to test the stationarity properties of the time series, the KPSS, PP, and ADF unit root tests were employed. The PP and KPSS unit root tests were initially employed since their asymptotic critical values are the same, which also gives a robust check for serial autocorrelation and heteroskedasticity, and they also do not give room for the selection of lag length criteria. This defines the basis for the selection of the KPSS and PP unit root tests. However, to check for consistency in the stationarity of the series, the ADF unit root test was also employed. Table 4 presents the summary of the ADF, PP, and KPSS unit root tests through the test equation of intercept, and tend and intercept shows that capital formation, domestic savings, foreign direct investment, and domestic credit to the private sector are of mixed stationary at level and first difference.

Table 4 Summary of the unit root test

Test Equation: Intercept						
Variables	**Level**			**First Difference**		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
GDP_t	-3.6256$^{\Psi}$ (-2.9604)	-3.7506$^{\Psi}$ (-2.9604)	0.1566$^{\Psi}$ (0.4630)	- (-)	- (-)	- (-)
$GCFR_t$	-10.0813$^{\Psi}$ (-2.9639)	-10.6328$^{\Psi}$ (2.9604)	0.0934$^{\Psi}$ (0.4630)	- (-)	- (-)	- (-)
$LGEDU_t$	-5.8537$^{\Psi}$ (-2.9677)	-1.4126 (-2.9604)	0.7112 (0.4630)	- (-)	-3.3892† (-2.9639)	0.3002† (0.4630)
$LGHE_t$	-4.9419 (-2.9677)	-2.1530 (-2.9604)	0.7198 (0.4630)	-5.8140† (-2.9639)	-11.2407† (-2.9639)	0.3317† (0.4630)
SAV_t	-2.1904 (-2.9639)	-2.3880 (-2.9604)	0.6853 (0.4630)	-7.2148† (-2.9639)	-7.9150† (-2.9639)	0.3450† (0.4630)
FDI_t	-3.0372$^{\Psi}$ (-2.9604)	-3.0372$^{\Psi}$ (-2.9604)	0.3618$^{\Psi}$ (0.4630)	- (-)	- (-)	- (-)
DCP_t	-2.5672 (-2.9639)	-1.7184 (-2.9604)	0.5705 (0.4630)	-5.0548† (-2.9718)	-5.9838† (-2.9639)	0.5000† (0.7390)
Test Equation: Trend and Intercept						
Variables	**Level**			**First Difference**		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
GDP_t	-3.5418 (-3.5628)	-3.6741$^{\Psi}$ (-3.5628)	0.1541 (0.1460)	-8.8812† (-3.5683)	- (-)	0.1577† (0.2160)
$GCFR_t$	-9.8938$^{\Psi}$ (-3.5683)	-10.3554$^{\Psi}$ (3.5628)	0.0762$^{\Psi}$ (0.1460)	- (-)	- (-)	- (-)
$LGEDU_t$	-5.7049$^{\Psi}$ (-3.5742)	-3.0373 (-3.5628)	0.1987 (0.1460)	- (-)	- (-)	0.4000† (0.4630)
$LGHE_t$	-3.5028 (-3.5742)	-2.9608 (-3.5628)	0.1946 (0.1460)	-9.9022† (-3.5683)	-36.7236† (-3.5683)	0.1577† (0.2160)
SAV_t	-3.1161 (-3.5628)	-3.0013 (-3.5628)	0.1140 (0.1460)	-7.5066† (-3.5683)	-8.7111† (-3.5683)	0.1752† (0.2160)
FDI_t	-3.8955 (-3.5628)	-3.5850 (-3.5628)	0.0765 (0.1460)	- (-)	- (-)	0.1402† (0.1460)
DCP_t	-3.7738$^{\Psi}$ (-3.5628)	-2.1149 (-3.5628)	0.1892 (0.1460)	- (-)	-6.0238† (-3.5683)	0.5000† (0.2160)

$^{\Psi}$ and † imply stationary at level and first difference respectively.

Source: Authors' computation.

3.2. ARDL cointegration bound test

However, despite the mixed series stationarity from the unit root test, it means that the Ordinary Least Squares, VAR, and VEC models cannot be used while the study employs the ARDL model (Pesaran & Shin, 1995; Shrestha & Bhatta, 2018). However, despite the choice of econometric method, there is a need to determine the direction of the variables using the ARDL bounds test, which has distinct benefits over existing symmetric co-integration tests (Pesaran, Shin, & Smith, 2001). This is done to know the cointegration among the variables, and the model of the ARDL bound test is specified in (7) as follows:

(7)

$$\Delta GDP_t = \delta_0 + \lambda_1 GDP_{t-1} + \lambda_2 GCFR_{t-1} + \lambda_3 LGEDU_{t-1} + \lambda_4 LGHE_{t-1} + \lambda_5 SAV_{t-1} + \lambda_6 FDI_{t-1} + \lambda_7 DCP_{t-1} + \sum_{i=1}^{u} \gamma_{1i} \Delta GDP_{t-i} + \sum_{j=1}^{v} \gamma_{2j} \Delta GCFR_{t-j} + \sum_{j=1}^{v} \gamma_{3j} \Delta LGEDU_{t-j} + \sum_{j=1}^{v} \gamma_{4j} \Delta LGHE_{t-j} + \sum_{j=1}^{v} \gamma_{5j} \Delta SAV_{t-j} + \sum_{j=1}^{v} \gamma_{6j} \Delta FDI_{t-j} + \sum_{j=1}^{v} \gamma_{7j} \Delta DCP_{t-j} + \eta_t \quad (7)$$

Where Δ are the operators of the first difference, $\lambda_1 - \lambda_5$ are the vector parameters of the long-run estimates, $\gamma_1 - \gamma_5$ are the vector parameters of the short-run estimates, *p* is the optimal lag length, δ_0 is the constant parameters, and η_t is the white noise. Table 5 revealed the results of the ARDL bound test revealing that the variables move jointly in the same trend and that there is a long-run cointegration between the series indicating that capital formation and economic growth in Nigeria has a disequilibrium in the specified ARDL bound model since the F-statistic is above the 5% critical value of the upper bound.

Table 5 ARDL bounds test

Significance	**Lower Bound**	**Upper Bound**	**Selected Model**	**Test Statistic**	**Value**	**K**
10%	2.08	2.94	ARDL (2, 0, 2, 0, 2, 2, 1)	F-statistic	4.651679	6
5%	2.39	3.28				
2.5%	2.55	3.61				
1%	3.06	3.99				

Source: Authors' computation.

3.3. ARDL and ECM estimates of capital formation and economic growth

Therefore, to correct the long-run cointegrated model to the short-run, the ECM can be used. As a result, it means that the ECM estimation technique is employed to adjust the disequilibrium in the long run with the use of Error Correction Term (ECT) to minimize the sum of squared residuals. However, because there is also a likelihood of co-integration, the ECM is estimated in the short run to correct the disequilibrium from the long-run co-integration results of the ARDL. Though, from (7), the ARDL long-run model based on the selected model is estimated in (8) as,

$$GDP_t = \delta_0 + \lambda_1 GDP_{t-1} + \lambda_2 GDP_{t-2} + \lambda_3 GCFR_t + \lambda_4 LGEDU_t + \lambda_5 LGEDU_{t-1} + \lambda_6 LGEDU_{t-2} + \lambda_7 LGHE_t + \lambda_8 SAV_t + \lambda_{10} SAV_{t-1} + \lambda_{11} SAV_{t-2} + \lambda_{12} FDI_t + \lambda_{13} FDI_{t-1} + \lambda_{14} FDI_{t-2} + \lambda_{15} DCP_t + \lambda_{16} DCP_{t-1} + \eta_t \quad (8)$$

Results from Table 6 revealed that in the long run, physical capital formation through gross capital formation has a positive and insignificant effect on economic growth. This means that a unit increase in Nigeria's gross capital formation positive insignificant increase in economic growth of 3.96%. This result is in support of Onyinye, Idenyi, and Ifeyinwa (2017). The study found that recurrent expenditure on education, initially and when delayed by two periods, positively impacts Nigeria's economic growth, but significantly increases it when delayed by one period implying that in all periods in the long run, a unit increase in recurrent expenditure on education increases economic growth by 9.33%, 5.11%, and 6.54%, respectively. This is in line with Ayeni and Omobude (2018). On the other hand, the recurrent expenditure on health insignificantly harms economic growth. This means that in the long run, a unit increase in the recurrent expenditure on health will result in a decrease in economic growth of 12.1%. The result is not inconsistent with Keji (2021). The savings rate in Nigeria positively impacts economic growth when lagged by one or two periods, but only significant when lagged by two periods. The initial savings rate has a decreasing effect, with an increase in savings causing a 0.01% reduction in economic growth after its initial period, and this is not in line with the findings of Abraham and Adama (2021).

The long-run results also revealed that foreign direct investment at its initial level and when lagged by two periods has a positive but insignificant effect on Nigeria's economic growth, but when lagged by one period, it has a negative and insignificant effect on economic growth in the long run. This means that at its initial level and when lagged by two periods in the long run, a unit increase in foreign direct investment increases economic growth by 1.22% and 0.57%, respectively, while when lagged by one period, it reduces economic growth by 0.92%. The result is in line with Oyegoke and Aras (2021). Domestic credit to the private sector at its initial level insignificantly retards Nigerian economic growth by 0.62%, while when lagged by one period, it positively and significantly increases economic growth by 0.73%. The result is in line with Amoo, Eboreime, Adamu, and Belonwu (2017). Moreover, the long-run model results passed the first test of regression, where the value of the model's Durbin-Watson is greater than the adjusted R-squared, and the model is statistically significant since the probability of the F-statistic is significant at 5%, respectively. The ARDL long-run model result is also stable

because the adjusted r-squared is highly above 50%. The economic implication is that the long-run results are good for policy implementation.

Table 6 ARDL long-run empirical results

Variable	**Coefficient**	**Std. Error**	**t-Stat.**	**Prob.**
GDP_{t-1}	0.196260	0.152612	1.286007	0.2193
GDP_{t-2}	0.234350	0.190060	1.233031	0.2379
$GCFR_t$	0.039646	0.044768	0.885587	0.3908
$LGEDU_t$	9.336095	6.992647	1.335130	0.2031
$LGEDU_{t-1}$	5.114041	2.029594	2.519736	0.0245
$LGEDU_{t-2}$	6.543464	4.987878	1.311873	0.2107
$LGHE_t$	-12.10453	9.186754	-1.317607	0.2088
SAV_t	-0.016858	0.083604	-0.201647	0.8431
SAV_{t-1}	0.184040	0.098615	1.866241	0.0831
SAV_{t-2}	0.286032	0.082823	3.453527	0.0039
FDI_t	1.224511	1.470571	0.832677	0.4190
FDI_{t-1}	-0.927485	0.542123	-1.710839	0.1092
FDI_{t-2}	0.579129	0.471834	1.227399	0.2399
DCP_t	-0.625305	0.295500	-2.116093	0.0527
DCP_{t-1}	0.736216	0.279856	2.630692	0.0198
Constant	-35.13013	7.172810	-4.897680	0.0002
Adjusted R-squared	0.662416		Durbin-Watson stat	2.138283
F-statistic	4.793635		Prob. (F-statistic)	0.002773

Source: Authors' computation.

Table 7 further shows the short-run effect which is specified through the ECM by automatically removing the variables with the initial period from the specified ARDL long-run model as estimated in (9),

$$\Delta GDP_t = \delta_0 + \sum_{i=1}^{u} \gamma_{1i} \Delta GDP_{t-i} + \sum_{j=1}^{v} \gamma_{2j} \Delta GCFR_{t-j} + \sum_{j=1}^{v} \gamma_{3j} \Delta LGEDU_{t-j} + \sum_{j=1}^{v} \gamma_{4j} \Delta LGHE_{t-j} + \sum_{j=1}^{v} \gamma_{5j} \Delta SAV_{t-j} + \sum_{j=1}^{v} \gamma_{6j} \Delta FDI_{t-j} + \sum_{j=1}^{v} \gamma_{7j} \Delta DCP_{t-j} + \eta_t \quad (9)$$

The short-run results of the ECM through the ECT show that recurrent expenditure on education significantly impacts Nigerian economic growth by 9.33%, but when lagged by one

period, it harms growth by 6.54%. Foreign direct investment also negatively impacts growth by 0.28% but improves by 1.22% when lagged by one period. Domestic private credit access and savings rates have a negative and insignificant effect on economic growth by 0.01% and 0.57%, respectively. The error correction term (ECT) coefficient in the short-run estimates reflects the rate at which any disequilibrium in the model is adjusted towards a long-run equilibrium. The ECT coefficient is negative and significant, indicating that the short-run offsets by 0.63% of the model's disequilibrium annually to restore long-run equilibrium, resulting in a 63% adjustment rate in the year after the sampling period.

Table 7 ECM short run empirical results

Variable	Coefficient	Std. Error	t-Stat.	Prob.
$\Delta(GDP_{t-1})$	-0.234350	0.094715	-2.474254	0.0268
$\Delta(LGEDU_t)$	9.336095	1.890688	4.937935	0.0002
$\Delta(LGEDU_{t-1})$	-6.543464	1.479726	-4.422078	0.0006
$\Delta(SAV_t)$	-0.016858	0.050257	-0.335446	0.7423
$\Delta(FDI_t)$	-0.286032	0.057672	-4.959669	0.0002
$\Delta(FDI_{t-1})$	1.224511	0.397668	3.079227	0.0082
$\Delta(DCP_t)$	-0.579129	0.313356	-1.848151	0.0858
ECT_t	-0.625305	0.186827	-3.346968	0.0048
Adjusted R-squared	0.742557		Durbin-Watson stat	2.138283

Source: Authors' computation.

3.4. Stability test results

Table 8 shows the results of the stability test, which relay that the model has no econometric estimation problem as estimated for the ARDL long-run and ECM short-run results, respectively. The result showed that the Breusch-Godfrey serial correlation LM test and the heteroscedasticity test using the Glejser test were not rejected, which means that the probability values were greater than the 5% significance level. Therefore, the consequence of the results is that the model does not have autocorrelation or heteroscedasticity.

Table 8 Post diagnostic test results

Diagnostic test	Decision	F-Statistic	Prob. Value
Jarque-Bera Normality Test	The model is normally distributed	JB = 0.0671	0.9670
Breusch-Godfrey Serial Correlation LM Test	The model does not have autocorrelation	0.0558 (2,12)	0.9460
Glejser Heteroscedasticity Test	The model does not contain heteroscedasticity	0.7961 (15,14)	0.6673

Source: Authors' computation.

To uphold these findings from Table 8, the recursive estimation of the cumulative sum (CUSUM) test and the cumulative sum of squares (CUSUM Squares) test respectively depicts that the model is stable having its residuals laying within the 95% confidence interval as shown in Figure 1.

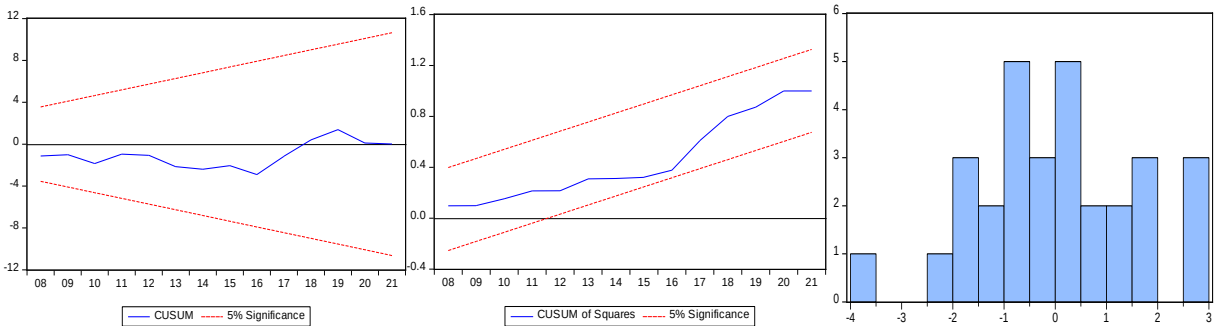

Figure 1 CUSUM, CUSUM of Squares Test at 5% Significance and Normality Histogram.
Source: Authors' computation from Eviews10.

Conclusion

The study explored the relationship between disaggregated capital formation and economic growth in Nigeria from 1990 to 2021. It reveals that while Nigeria has experienced significant economic growth, the variability in gross capital formation and government expenditures on education and health suggest challenges in capital accessibility, particularly for the private sector. The correlation analysis shows that gross capital formation, government expenditures, savings, and credit access have a positive but insignificant correlation with economic growth, while foreign direct investment has a negative and insignificant correlation. This result indicates that gross capital formation, government expenditures, savings, and credit access promotes economic growth but not significantlty, and this results supports the findings of Onyinye, Idenyi, and Ifeyinwa (2017), and Abraham and Adama (2021).

Also, the study highlights the interconnectedness of capital formation and economic growth, suggesting policy recommendations to enhance human capital through increased investment in education and health and improve credit access by addressing high interest rates. The government should also focus on improving educational infrastructure, teacher training, and curriculum development to align with the modern economy. Additionally, the government should address high interest rates that hinder private-sector borrowing and capital growth to support sustainable economic growth. Future research should explore the impact of different

types of foreign direct investment on economic growth and the role of technological innovation and infrastructure development in capital formation and economic growth.

Grant support: This paper has not received any foreign sources or been funded by any grant agency.

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