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COMPARATIVE ANALYSIS OF THE EFFECTIVENESS OF COUB-DOUGLAS, REAL BUSINESS CYCLE, AND KEYNSIAN GROWTH MODELS IN DETERMINING ECONOMIC GROWTH IN NIGERIA

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ABSTRACT

Choosing the most suited growth theory in determining output in Nigeria has been a problem for researchers and policy maker. They have been faced with the question of what drive growth of the Nigerian economy: output derived from supply of capital (savings), or output derived from aggregate demand (spending) or due to shock to technology? This study empirically examined the relative effectiveness of the Cobb-Douglas Production function, the Real Business Cycle model and the Keynesian model to determine growth drivers of the Nigerian economy. Error correction model and vector error correction model was used to examine the relative effectiveness of the three growth models in determining output in Nigeria. The result of the study showed that only the coefficient of technology significantly determined economic growth in Nigeria using the Cobb-Douglas production function. Capital and labour significantly determined gross domestic product in Nigeria in the third year, adopting the vector error correction for the Real Business Cycle model. The Keynesian model proved most significant as all explanatory variables, such a consumption expenditure, investment, government spending and balance of payment were significant determinants of Nigerian economic growth. The explanatory variables jointly contributed the most (58.43%) to the variation in the gross domestic product of Nigeria. Real gross domestic product had positive autonomous growth in the Keynesian model but negative autonomous growth using the other two models. Technology input in production should be boosted by increasing government expenditure in education/ enhanced skill acquisition and the employment of more graduates in the productive sectors of the economy. Researchers and policy makers should henceforth adopt the Keynesian growth model as the most suited for the Nigerian economy.

Contribution/ Originality: The study originates new formula for estimating technological input in production by estimating its input in labour and capital.

1. INTRODUCTION

The cause of economic growth is an intensely argued issue as it concerns two schools of thought; the Keynesian/Institutionalist School and the Orthodox (or Neoclassical) School (Waller, 2000). Waller posits that both schools differ fundamentally in views on the way growth is brought about and in the way it is sustained. Their major deviation is on the saving-investment relation.

Greiner (2010) explained that the 1.5% growth rate of the world's annual average per-capita GDP, from 1900 to early 1990s signified a quadruple increase in the period. He further noted that in Western European countries, GDP growth was still larger with an average yearly growth rate of roughly 1.9%, which suggests that per-capita GDP in the early 1990's was 5.6 times greater than in 1900, whereas the rise in overall output does not seem too surprising as a country's population growth does not necessarily hold for per-capita output.

Waller (2000) contends that in line with the neoclassical school, growth is a result of increased savings, while Keynesians believe that growth comes about through a rise in either corporate investment or government investment, or both, resulting either from an increase in the money supply, lower interest rates, or a rise in income. On the other hand, although real business cycle theory is based on the Cobb-Douglas production function, its proponents, Kydland and Prescott (1982); Altug (1989); Canova *et al.* (1994) and Farmer (1993) argue that shock to technology or change in preference of technology shock is the growth driver.

The pertinent question therefore is whether growth is attributed to investment derived from savings (supply of capital), or investment derived from aggregate demand (spending), or due to deviation in the regular state as a result of shock to technology? These theories could have been effective in causing growth in some economies, but have differed relatively in their effectiveness in causing growth in the Nigeria, which have remained a developing economy for far too long, evidenced in a fluctuating gross domestic product.

Choosing the most suited growth theory in determining output in Nigeria has been a problem for researchers and policy maker. Over time, most researchers have had to choose a framework by casting dice or trial and error or just due to familiarity with the arguments of a particular school of thought. Little reflection has been made on the environment on which the study is done. This has given rise to increasing conflict of results and policies that have not been effective in growing the Nigerian economy and contributed to making the topic a great research burden.

The underperformance of the Nigerian economy considering its large resource endowment when compared to the rising Asian countries, notably, China, Malaysia, India, and Indonesia with lower per capita GDP in 1970 but have, in recent past, transformed their economies to become major players on the global economic scene motivated an indebt search into the key factors driving economic growth in Nigeria against the backdrop of theory and other countries experience, particularly the emerging countries (Udeaja and Onyebuchi, 2015). Citing example, they reechoed (Sanusi, 2010) report that China is positioned as the world's second largest economy although in 1970, in order of hierarchy, Nigeria had a GDP per capita of US$233.35 and was ranked 88th in the world, while China was ranked 114th with a GDP per capita of US$111.82.

Furthermore, the constant recession that plagues Nigeria poses the question whether the growth theories adopted (if any) in Nigeria effectively grows the gross domestic product. The Nigerian economy, like many developing countries, has had a volatile "growth-history" (Udeaja and Onyebuchi, 2015). According to them, this does not permit sustained economic growth, which is essential for long-run development and stability. It is therefore necessary to test these theories with data from Nigeria in order to ascertain the theory that best impacts economic growth in Nigeria.

1.1. Objectives of the Study

The main objective of this study is to determine whether economic growth in Nigeria is finance-led, induced by aggregate demand or as a result of shock to technology. In order to satisfy the main objectives, three sub objectives were developed. They are;

1. To evaluate the effectiveness of Cobb-Douglas production function in ascertaining economic growth in Nigeria.
2. To assess the effectiveness of Real Business Cycle model in determining economic growth in Nigeria.
3. To ascertain the effectiveness of Keynesian model in model in determining economic growth in Nigeria.

1.2. Research Hypotheses

In line with the objectives, the following hypotheses developed and stated in null form.

$H0_1$ Cobb-Douglas production function does not significantly ascertain economic growth in Nigeria.

$H0_2$ Real Business Cycle model does not significantly determine economic growth in Nigeria.

$H0_3$ Keynesian model does not significantly determine economic growth in Nigeria.

2. LITERATURE REVIEW

The Cobb-Douglas functional form of production functions is widely used to represent the relationship of an output to inputs. They bethought a simplified view of the economy whereby production output is determined by the total labor involved and the amount of capital invested (Bao Hong, 2008). He explained that their assumptions were founded on the premise that if either labor or capital vanishes, then so will production. Secondly, Bao Hong reported their argument that the marginal productivity of labor is proportional to the amount of production per unit of labor, and the marginal productivity of capital is proportional to the amount of production per unit of capital. However, according him, their theory was not without fault as they were influenced by statistical evidence that revealed that labor and capital share of total output were constant over time in developed countries. Neither Cobb nor Douglas provided any theoretical reason why the marginal productivity of labour and the marginal productivity of capital should be constant over time or be the same between sectors of the economy (Bao Hong, 2008).

On the other hand, the real business cycle is notable for its emphasis on microfoundations: macroeconomic fluctuations are the outcome of maximizing decisions made by many individual agents (Stadler, 1994). Stadler argued that to obtain aggregates, one adds up the decision outcomes of the individual players, and imposes a solution that makes those decisions consistent.

Keynes argued that the essence of development economics is the belief that the development process is better served by chasing policies that enhance growth with existing hurdles than by simply trying to remove these hurdles in the hope that development will then occur (Grabowski and Shields, 2000). They explained that a coherent Keynesian approach to growth built on three basic principles: the economic system may not tend to full employment; investment decisions are independent of saving decisions; the autonomous components of demand may affect the economic growth rate. Therefore, effective demand plays an essential function in affecting the growth path of the economy and thus in pushing the economic system close to full employment (Grabowski and Shields, 2000).

Udeaja and Onyebuchi (2015) studying the determinants of Nigeria's economic growth, adopted a real business cycle theory approach. They believed that Nigeria faces high volatile growth history and employed the vector error correction methodology to model the volatility of the growth of Nigeria and the shock to education (a proxy used to measure technological change) The results of the VECM discloses that while domestic savings, expenditure on education, openness, and financial depth (in the second lag) are positive determinants of economic growth, FDI and public infrastructure do not drive economic growth in Nigeria. It was also discovered that expenditures on health had negative effects on growth.

Considering the relationship between economic growth and fiscal deficit, Ezeabasili et al. (2012) examined the relationship within the Nigerian context, using data during the period, $1970 - 2006$. They used a modeling technique that incorporates cointegration, error correction mechanism, variance decomposition and structural analysis. The results show that (i) fiscal deficit negatively affects economic growth, with an adjustment lag in the system; (ii) a 1% increase in fiscal deficit is capable of tapering economic growth by about 023%; and (iii) there is a strong negative connection between government consumption expenditure and economic growth.

Ismaila and Imoughele (2015) examined the macroeconomics determinants of economic growth in Nigeria, using ordinary Least Square statistical technique to evaluate the degree of influence the variables have on each

other. Their study indicated that foreign direct investment, gross fixed capital formation and total government expenditure were the main determinants of Nigeria economic output under a stable inflationary rate.

Madichie *et al.* (2014) investigated the influence of financial development on economic growth in Nigeria during the period 1986 − 2012. The normalized cointegration coefficients revealed that financial development affects economic growth negatively in the long run. However, the short run impact of financial development on economic growth was positive, implying that the finance-led growth hypothesis was valid in Nigeria in the short run. The study further showed that causal relation flows from economic growth to financial lending support to the demand-leading hypothesis regarding Nigeria.

Looking at the implication of saving and investment on economic growth in Nigeria, Nwanne (2014) tried to evaluate the implications of savings and investment on economic growth in Nigeria using ordinary least square regression technique. Results from the study proved that change in gross domestic savings movements has negative and notable effect on the change in economic growth in Nigeria and that the change in gross domestic investment has positive and notable effect on the change in the Nigerian economic growth.

Having reviewed some relevant theories and empirical literature and discovered that most studies on determinants of Nigeria's economic growth failed to fully adopt the variables as modeled by the proponents (especially, technology and labour), rather they narrowly evaluated selected disaggregated factor impact on the growth of the Nigerian economy. It becomes undoubtedly critical to analyze the relative effectiveness of the Cobb-Douglas model, the Keynesian model and the real business cycle model on economic growth in Nigeria and to fill the gap.

3. METHODOLOGY

The framework on this study is based is the Cobb-Douglas production function, real business cycle theory and Keynesian growth theory. These are the theories being tested for determining GDP in Nigeria. According to Bao Hong (2008) the function Cobb-Douglas used to model production was of the form:

$$P(L,K) = bL^{\alpha}K^{\beta} \qquad (3.1)$$

Where:
- P = total production (the value of money of all goods produced in a year)
- L = labor input (the total number of hours a person worked in a year)
- K = capital input (the worth of money of all machinery, equipment, and buildings)
- b = total factor productivity or technology.
- α and β are the output elasticities of labor and capital, respectively. These values are constants determined by the technology available. α may be used interchangeably as $1 - \beta$

Notably, technology according to Hartley *et al.* (1997) is estimated using the Solow residual (Solow, 1957). This is modeled thus;

$$\log(Z) = \log(Y) - \Theta\log(L) - (1 - \Theta)\log(K) \qquad (3.2)$$

Hartley *et al.* (1997) explained that when computed using actual data, the Solow Residual, like the series used to compute it, has a trend and so must be detrended before being used as an input to the model. However, the real values of labour (L) cannot be subtracted from monetary value of output (Y) as much as the monetary value of capital (K). Therefore, the Solow residual cannot be used to estimate technology in Nigeria as Solow (1957) postulates.

Real business cycle theory argues that shock to technology is responsible for the change in output, following the assumption that technology develops over time according to an *AR*(1) process. Therefore, the real business cycle model, taken from the Cobb-Douglas production model is as follows;

$$Y_t = A_{t-1}L_t^{\Theta}K_t^{1-\Theta} \qquad (3.3)$$

Where,

Y_t = Output, K_t = Capital, A_{t-1} = Technology [using $AR(1)$], L_t = labour, Θ is the share of labour in National output. To solve the model, its equations are typically reformulated as linear approximations around the unknown steady state. This is the technical sense in which real business cycle abstracts from the interests of the theory of traditional growth; for no explanation of the steady state is sought; the focus is on deviations from the regular state caused by shock to technology (Stadler, 1994).

Keynesian theory however, argues that GDP is propelled by aggregate demand. The GDP which equals national income at time (t), then, is given by $Y(t) = C(t) + I(t)$ in a closed economy, without government interference (Greiner, 2010). Given that Nigeria operates an open economy, the Keynesian growth model is as follows:

$$Y = C + I + G + XM \tag{3.4}$$

In line with the objectives and hypotheses, the basic models for the study therefore are;

1.   **GDP   = f (K_t, A_t, L_t)**   **(3.5)**

Therefore,

GDP   = f (GCF_t, PSc_t, $GEEK_t$, $OHILF$, L_t)   (3.6)

To make (3.7) stochastic

$$GDP_t = B_0 + B_1K_t + B_2A_t + B_3L_t + \mathcal{E} \tag{3.7}$$

Where,

GDP   = gross domestic product

K   = Capital (gross fixed capital formation + credit to private sector)

A   = Technology/ knowledge (Government expenditure on education + graduate turnout from higher institutions in Nigeria)

L   = employed Labour

$\mathcal{E}$ = error term

2.   **GDP   = f (K_t, A_{t-1}, L_t)**   **(3.8)**

Therefore,

GDP = f (GCF_t, PSc_t, $GEEK_{t-1}$, $OHILF_{t-1}$, L_t)   (3.9)

To make (3.10) stochastic

$$GDP_t = B_0 + B_1K_t + B_2A_{t-1} + B_3L_t + \mathcal{E} \tag{3.10}$$

Where,

GDP   = gross domestic product

K   = Capital (gross fixed capital formation + credit to private sector)

A   = Technology/ knowledge, using $AR(1)$ (Government expenditure on education + graduate turnout from higher institutions in Nigeria)

L   = employed Labour

$\mathcal{E}$ = error term

3.   **GDP = f (CE_t, I_t, G_t, XM_t)**   **(3.11)**

To make it stochastic

$$GDP_t = B_0 + B_1CE_t + B_2I_t + B_3G_t + B_4XM_t + \mathcal{E} \tag{3.12}$$

Where,

GDP   = Gross domestic product

CE   = Consumption Expenditure

I   = Investment (credit to both private sector and the government)

G   = Government Expenditure

XM   = Balance of payment

Ɛ   = error term

In the first model, Capital (K) was estimated by adding gross fixed capital formation (GCF) and credit to private sector (PSc), while the summation of the ratio of graduate turnout from higher institutions in Nigeria to total labour force (OHI*LF*) and the ratio of government expenditure on education in Nigeria to capital (GEE*k*) was estimated as the technology (A). This was deduced from the Solow residual. Therefore, OHI*LF* measures technological input in labour while GEE*k* measures technological input in capital.

In the Real business cycle model, Capital (K) was estimated by adding gross fixed capital formation (GCF) and credit to private sector (PSc), while the summation of the ratio of graduate turnout from higher institutions in Nigeria to total labour force (OHI*LF*) and the ratio of government expenditure on education in Nigeria to capital (GEE*k*) was calculated as the technology (A) [RBC theory uses $AR(1)$ for technology]. This was deduced from the Solow residual. OHI*LF* measures technological input in labour while GEE*k* measures technological input in capital.

For the Keynesian growth model, Credit to private sector was estimated from commercial banks' credit to private sector, merchant banks' credit to private sector, community/microfinance banks' credit, finance houses' and discount houses' credits to private sector. The use of the sum of ratio of graduate turnout from higher institutions in Nigeria to employed labour (labour input in production) and the ratio of government expenditure in education to capital input in production as knowledge (technology), and the rate of graduate turnout as rate of technological advancement is supported by the Nigerian Bureau of Statistics (NBS) as their release of the annual abstract of statistics, 2012 explained that graduates from colleges of education were trained for three (3) years as middle level manpower in teaching education and awarded the Nigerian Certificate in Education (NCE). Furthermore, the Bureau clarified that graduates from Polytechnics were also trained as middle level manpower at the sub-professional level in two categories – the National Diploma (ND) and the Higher National Diploma (HND). Thirdly, the Bureau explained that the universities produced first class degrees at Bachelor, Master, and Doctoral level (NBS, 2014). These higher institutions are measured with high standards to assure the quality of graduates while being supervised by the Federal Ministry of Education, National Board for technical Education (NBTE) and Nigerian University Commission (NUC) among others (Nigerian Bureau of Statistics, 2014). The time series data of employed labour in Nigeria was used as the labour input in production. Investment was calculated using time series data of credit to private sector as explained earlier plus commercial and merchant banks' credit to federal, state and local governments in Nigeria. This captures domestic investments as foreign direct investments and foreign capital flows were factored in the balance of payment. The data were sourced with strict adherence to the models. Technology (A) was estimated thus:

A = GEE*K* + OHI*LF*

Where,

GEE*K*   = GEE / K (technological input via capital)

OHI*LF* = OHI / LF (technological input via labour)

In line with previous similar studies on the determinants of economic growth in Nigeria and due to non stationarity of variables at level form, error correction mechanism (ECM) and vector error correction mechanism (VECM) was used to test the hypothesis of the study (Ezeabasili *et al.*, 2012; Madichie *et al.*, 2014; Nwanne, 2014; Udeaja and Onyebuchi, 2015). VAR model can be expressed as:

$$\text{yt} = A_0 + \mathscr{L}^p\, t = 1\ At - 1\ U_t \qquad\qquad 3.13$$

Where yt = (Y₁+... Y_{kt}) is a column vector of observation on the current values of all variables in the model, A, is K x K matrix of unknown coefficients, A_0 is a column vector of deterministic constant terms, U_t is a column vector of errors with properties of $E(U_t) = O$ for all t, $E(U_S\, U_t) = \Omega$ if s = t

O if s ≠ t

Where Ω is the variance - covariance matrix U$_t$ is are not serially correlated but may be contemporaneously correlated, thus, Ω is assumed to have non-zero off-diagonal elements.

Data was sourced from the central bank of Nigeria (CBN) statistical bulletin and the Nigerian bureau of statistics (NBS). Gross fixed capital formation, credit to private sector, consumption expenditure, gross domestic product, government expenditure and balance of payment were sourced from the Central Bank of Nigeria (2016) time series data of employed labour was calculated using total labour force in Nigeria sourced from UNCTAD (2014) and unemployment rate in Nigeria from the International Labour Organization (2016) (i.e. total Labour force less unemployed persons in Nigeria), while time series data of graduates from higher institutions (another proxy for knowledge/technology) in Nigeria was sourced from the NBS annual report.

4. DISCUSSION

4.1. Unit Root Test

Augmented Dickey-Fuller (ADF) Test

Variable	ADF Test Statistics	5% Critical Value	Order of Integration
GDP	**-6.494831**	-3.587527	I(2)
K	-5.297531	-3.574244	I(0)
L	-6.199871	-3.580623	I(1)
A	-3.845274	-3.580623	I(1)
CE	-5.401131	-3.603202	I(1)
I	-6.199871	-3.580623	I(1)
G	-3.888603	-3.595026	I(0)
XM	-3.927499	-3.658446	I(2)
LNGDP	**-7.323981**	-3.587527	I(2)
LNK	-7.511639	-3.580623	I(1)
LNL	-6.306036	-3.580623	I(1)
LNA	-5.579865	-3.580623	I(1)

Source: author's computation using e-view 9.5 software

The result of the Augmented Dickey Fuller test conducted at 5% significance level showed that capital (K) and government expenditure (G) were stationary at level and therefore had no unit root. However, gross domestic product (GDP), log of gross domestic product (LNGDP) and balance of payment (XM) were stationary at second difference. Employed labour (L), technology (A), consumtion expenditure (CE), investment (I), log of technology (LNA), log of capital (LNK), and log of employed labour LNL) were stationary at first difference. The variables Cobb-Douglas, Real Business Cycle and Keynesian models were stationary at different orders of integration. This implies that there are unit root problem in each model and suggesting that a cointegration test be conducted to determine the existense or not of a longrun relationship among the variables of each model.

4.2. Johansen Cointegration test for Cobb-Douglas and Real Business Cycle model variables [Gross Domestic Product (GDP), capital (K), Labour (L), and Technology (A)]

Hypothesized		Max-Eigen	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistics	Critical Value	
None *	0.692954	33.06123	27.58434	0.0089
At most 1	0.515920	20.31413	21.13162	0.0647
At most 2	0.210018	6.600847	14.26460	0.5374
At most 3	0.081096	2.368049	3.841466	0.1238

Max-eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

** Mackinnon *et al.* (1999) p-values

Source: author's computation using e-view 9.5 software

The Johansen cointegration test conducted at 5% level of significance revealed that there is a cointegrating equation among variables of Cobb-Douglas production function and Real Business Cycle model, indicating that there is a long-run relationship among the variables. This further suggests the adoption of an error correction mechanism and vector error correction mechanism for the model analyses in line with Madichie *et al.* (2014) and Udeaja and Onyebuchi (2015) respectively.

4.3. Error Correction Mechanism (ECM) Result for Cobb-Douglas Production Function

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.004657	0.008630	-0.539678	0.5946
D(L)	1.10E-08	5.40E-09	2.035418	0.0535
K	-9.78E-12	4.65E-11	-0.210563	0.8351
D(A)	1.365844	0.634400	2.152970	0.0420
ECM	-6.44E-10	9.15E-10	-0.703596	0.4887
R-squared	0.243747	Mean dependent var		0.001484
Adjusted R-squared	0.112225	S.D. dependent var		0.035588
S.E. of regression	0.033531	Sum squared resid		0.025860
F-statistic	1.853278	Durbin-Watson stat		3.005698
Prob(F-statistic)	0.153041			

Source: author's computation using e-view 9.5 software

The ECM result conducted at 5% level of significance showed that only the variable technology was a statistically significant and positive determinant of economic growth in the Cobb-Douglas production model. Employed labour had positive but insignificant impact on economic growth in Nigeria. Noteworthy, capital negatively determined economic growth in Nigeria. This is against the assertions of the model as labour capital and technology should positively determine output. Therefore, while labour and technology contributed positively towards the Nigerian economic growth, capital accumulated in Nigeria for the period of study negatively contributed to economic growth.

The ECM coefficient had the expected a priori sign, however, its speed of adjustment to long run equilibrium was less than 0.1%, following an insignificant adjustment to long run equilibrium (0.4887 > 0.5000).

The f-statistics further revealed that the joint effect of all variables of the model on economic growth was insignificant as the probability of f* id 0.153041, which is greater that the 5% level of significance. Furthermore, variations in the variables of the model (independent variables) caused 24.37% of the variation in the growth of the Nigerian economy, indicating that the model is not a good fit even as it is best linear unbiased estimation. On a positive note, using Breusch-Pagan-Godfrey test for heteroscedasticity at 5% significance level, the residual of the model had a constant variance (homoscedastic) but serial correlation was found present in the model having been tested using Breusch-Godfrey serial correlation LM test.

4.4. Vector Error Correction Mechanism (VECM) Result of Real Business Cycle Model
4.4.1. Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-42.64031	NA	0.000329	3.331451	3.521766	3.389632
1	68.67619	182.8771*	3.69e-07*	-3.476871*	-2.525296*	-3.185965*
2	81.65927	17.61989	4.95e-07	-3.261377	-1.548542	-2.737746

* Indicates lag order selected by the criterion

Source: author's computation using e-view 9.5 software

Taking into consideration a basic feature of the Real Business Cycle theory that shock to technology is the main driver of economic growth from the steady state alongside capital and labour, and the assumption that technology uses autoregressive to order one [$AR(1)$] function, the lag length selection criteria (LR, FPE, AIC, SC, HQ) revealed that lag one is the optimal lag point. This is in line with the assumption of Real Business Cycle theory and was adopted for the vector error correction mechanism analysis.

4.4.2. VECM Result

Variable	Coefficient	Std. Error	t–Statistic	Prob.
C(1)	-0.206817	0.093556	-2.210609	0.0420
C(2)	-0.163177	0.233175	-0.699807	0.4941
C(3)	-0.065367	0.239010	-0.273491	0.7880
C(4)	-0.021705	0.011133	-1.949654	0.0690
C(5)	-0.023387	0.010470	-2.233717	0.0401
C(6)	0.134810	0.343853	0.392059	0.7002
C(7)	0.834896	0.333653	2.502286	0.0236
C(8)	0.000649	0.014631	0.044389	0.9651
C(9)	-0.005667	0.012366	-0.458291	0.6529
C(10)	-0.000583	0.009124	-0.063849	0.9499
Determinant residual covariance		**0.000575**		
R-squared	0.509728	Mean dependent var		-3.74E-06
Adjusted R-squared	0.233950	S.D. dependent var		0.034934
S.E. of regression	0.030576	Sum squared resid		0.014958
Durbin-Watson stat	2.028448			

Source: author's computation using e-view 9.5 software

The VECM result presented above using least square estimation method was conducted at 5% level of significance. The result showed that the log of capital and log of labour significantly determined the Nigerian economic growth in the second lad. Therefore, capital and labour had statistically significant impact on the economic growth of Nigeria after two years. Their effect on the gross domestic product of Nigeria was insignificant after one year, however, in the third year, just as in the second year, capital had negative impact on economic growth as in the Cobb-Douglas model, while employed labour contributed positively to the growth of the Nigerian economy for the period of study. Technology impact on growth was insignificant in the two lags. Nonetheless, in the first lag it had positive impact, though not significant but in after the second year, the effect became negative on economic growth. Therefore, it implies that technology input in Nigeria is only productive in the first and second year, after which it becomes counterproductive or starts experiencing diminishing return in production. The joint effect of the lagged independent variables [D(LNGDP(-1),2) D(LNGDP(-2),2), D(LNK(-1)), D(LNK(-2)), D(LNL(-1)), D(LNL(-2)), D(LNA(-1)), D(LNA(-2))] on the GDP is 1.848327, suggesting insignificance.

In line with the argument of Real Business Cycle theory, shock to technology drives growth of output from the steady state. Although the Nigerian economy is still developing and thus has not reached a steady state, variance decomposition was used to x-ray the variation in the GDP on Nigeria for the period of study that was caused by shock to technology. The result showed that shock to technology did not cause any variation to the gross domestic product of Nigeria in the first year. In period two shock to technology caused 0.39% of the variation in the GDP (see appendix 4), which is insignificant according to the VECM result. In the third period, shock to technology caused 1.14% of the variation in the GDP (see appendix 4). However, this shock had a negative effect on the GDP in line with VECM result. Therefore, it can be deduced that shock to technology caused -1.14% of the variations in the gross domestic product of Nigeria.

The R² showed that variables of the Real Business Cycle model (independent variables) jointly caused 50.97% variation in the gross domestic product in Nigeria. The Real Business Cycle (RBC) model can be argued as fairly fitted, and a better fit than the Cobb-Douglas production model in determining economic growth (GDP) in Nigeria. The residual of the RBC model is homoscedastic (see residual graph in appendix 1) and evidenced in the Portmanteau test for Autocorrelation, the residual of the model is not auto-correlated.

4.5. Johansen Cointegration test for Keynesian Growth Model Variables [Gross Domestic Product (GDP), Consumption Expenditure (CE), Investment (I), government Expenditure (G), and Balance of Payment (XM)]

Hypothesized		Max-Eigen	0.05	Prob.**
No. of CE(s)	Eigenvalue	Statistics	Critical Value	
None *	0.944889	81.15553	33.87687	0.0000
At most 1 *	0.662524	30.41532	27.58434	0.0211
At most 2	0.458844	17.19332	21.13162	0.1631
At most 3	0.311190	10.43813	14.26460	0.1847
At most 4	0.004401	0.123490	3.841466	0.7253

Max-eigen value test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

** Mackinnon *et al.* (1999) p-values

Source: author's computation using e-view 9.5 software

The Johansen cointegration test conducted at 5% level of significance revealed that there are two (2) cointegrating equations among variables of Keynesian model, indicating that there is a long-run relationship among the variables. This further suggests the adoption of an error correction mechanism for the model analysis in line with Ezeabasili *et al.* (2012).

4.6. ECM Result of the Keynesian Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	22604777	2954962.	7.649770	0.0000
D(CE)	3.559734	1.487105	2.393734	0.0256
D(I)	1.012091	0.208175	4.861723	0.0001
D(G)	20.68001	9.319517	2.219000	0.0371
D(XM,2)	3.235517	1.330056	2.4432618	0.0236
ECM	-2.256419	1.221676	-1.846987	0.0782
R-squared	0.584263	Mean dependent var		32794221
Adjusted R-squared	0.489778	S.D. dependent var		16161038
S.E. of regression	11543803	Sum squared resid		2.93E+15
Durbin-Watson stat	1.145646			

Source: author's computation using e-view 9.5 software

Closely observing the result of the error correction model conducted at 5% level of significance, it is evident that consumption expenditure, investment, government expenditure, and balance of payment were statistically significant determinants of economic growth in Nigeria. Furthermore, the variable contributed positively to the growth of the gross domestic product in Nigeria. The joint effect of the regressors were also statistically significant (0.001007 < 0.05000). Among all explanatory variables, the coefficient of government expenditure contributed the most as a percentage (1%) increase in government spending grew the gross domestic product by 20.68%. this was

followed by consumption expenditure, balance of payment, and investment, 3.56%, 3.24%, and 1.01% respectively to the growth of the gross domestic product with each 1% increase in the variables.

Although the error correction coefficient had a speed of adjustment of -225.64%, its adjustment to long run equilibrium was insignificant (0.0782 > 0.0500). The sign of the ECM followed the a priori expectation. The independent variables jointly determined 58.43% of the variations in the gross domestic product of Nigeria and therefore, can be said to be fairly fitted. The residual of the model had a constant variance, which is desired but it also showed evidence of autocorrelation.

4.7. Test of Hypotheses

$H0_1$:   The first null hypothesis states that Cobb-Douglas Production function is not a significant determinant of economic growth in Nigeria. The result of the error correction mechanism for the Cobb-Doulas production model revealed that only technology significantly determined growth of the Nigerian economy. The joint effect of the regressors on the gross domestic product in Nigeria as evidenced by the probability of the f-statistics is 0.153041 and is greater than the significance level of 5%. Furthermore, 24.37% of the variation in the gross domestic product can be attributed to the variations in the independent variables. Owing to these revelations, we accept the null hypothesis.

$H0_2$:   The second null hypothesis states that the Real Business Cycle model is not a significant determinant of Economic growth in Nigeria. The VECM result showed that the log of capital and log of labour in the second lag were significant determinants of growth of the Nigerian economy. The f-statistics further suggested that the variables jointly did not significantly determine the growth of the gross domestic product in Nigeria. However, the coefficient of determination showed that the variables caused 50.97% variations in the gross domestic product. Again, following the result of the vector error correction mechanism, the null hypothesis is accepted.

$H0_3$:   The third null hypothesis states that Keynesian model did not significantly determine economic growth in Nigeria. The error correction mechanism result showed that all independent variable of the model significantly impacted on the gross domestic product in Nigeria. Furthermore, the probability of the f-statistics (0.001007 < 0.05000) showed that the independent variables are joint significant determinant of the growth of Nigerian economy. The R^2 showed that variations in the independent variables jointly caused 58.43% variation on the gross domestic product in Nigeria. On this note, the null hypothesis is rejected as the Keynesian model significantly determined economic growth in Nigeria.

5. CONCLUSION AND RECOMMENDATIONS

Analytically comparing the result of the Cobb-Douglas production function, Real Business Cycle model and Keynesian model, only one variable (technology) determined economic growth using the Cobb-Douglas production model, two variables (capital and labour) determined economic growth in Nigeria using the Real Business Cycle model, while all four (4) independent variables of the Keynesian model significantly determined economic growth in Nigeria. Secondly, the f-statistics of both Cobb-Douglas production model and the Real Business Cycle model was insignificant, while the f-statistics of the Keynesian model was significant in determining the growth of Nigerian economy. Thirdly, the independent variables of the Cobb-Douglas production model jointly caused 24.37% to the variations in gross domestic product of Nigeria, while the Real Business Cycle model variables and Keynesian model variables jointly caused 50.97% and 58.43% variation in the growth of the gross domestic product in Nigeria. Therefore, it is evident that in Nigeria, the Keynesian model presents the best growth model and therefore should be adopted by researchers and policy makers. The Cobb-Douglas Production model and Real Business Cycle model may be used to model output in the private sector or in conducting sectorial growth analysis.

Technology input in production via capital and labour should be boosted annually by increasing government expenditure on education, increasing the ratio of graduates to total labour force and employment of graduates in productive sectors of the economy. Researchers and policy makers should use Keynesian model as the best suited growth model in Nigeria for further studies, rather than the Cobb-Douglas production function and Real Business cycle model. Lastly, government expenditure granger causes investment (see appendix 6). Therefore, government needs to increase spending in order to increase investment and in turn employment, especially of skilled labour, which in turn boost technological input in production via employed labour.

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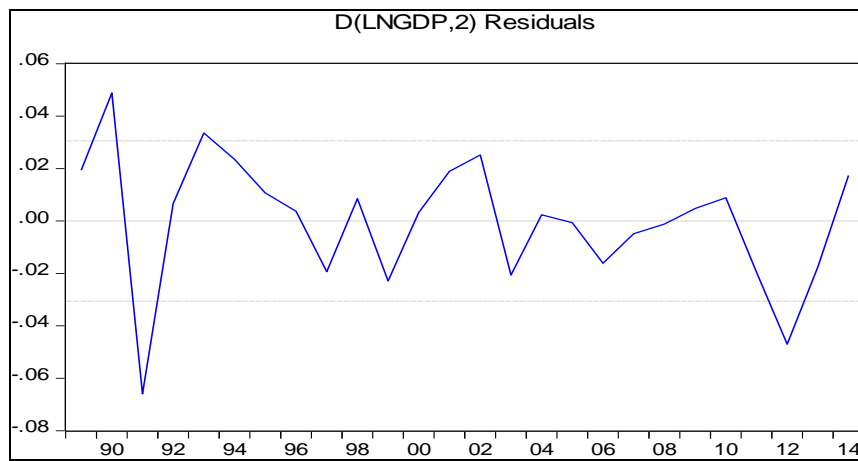Stadler, G.W., 1994. Real business cycles. Journal of Economics Literature, 32(12): 1750-1783. *View at Google Scholar*

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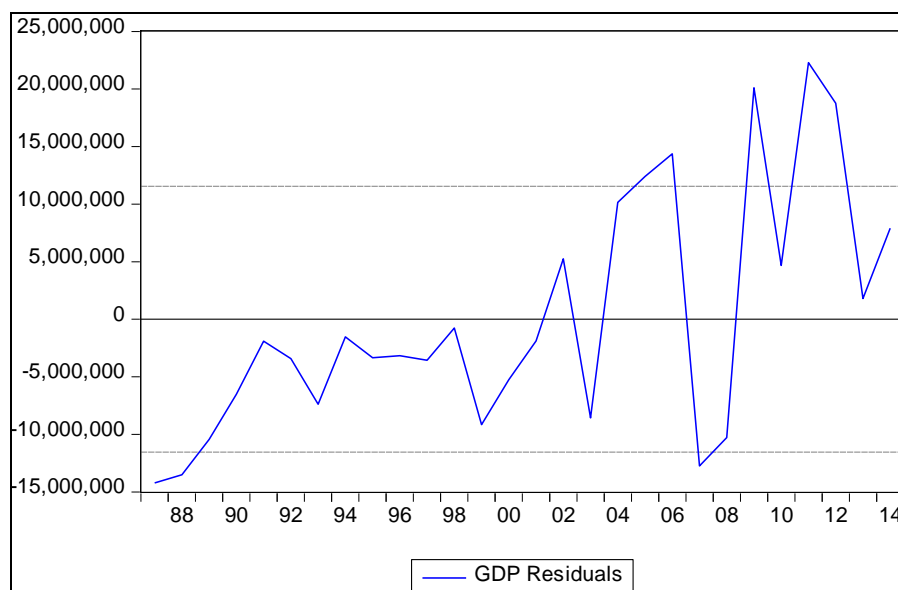
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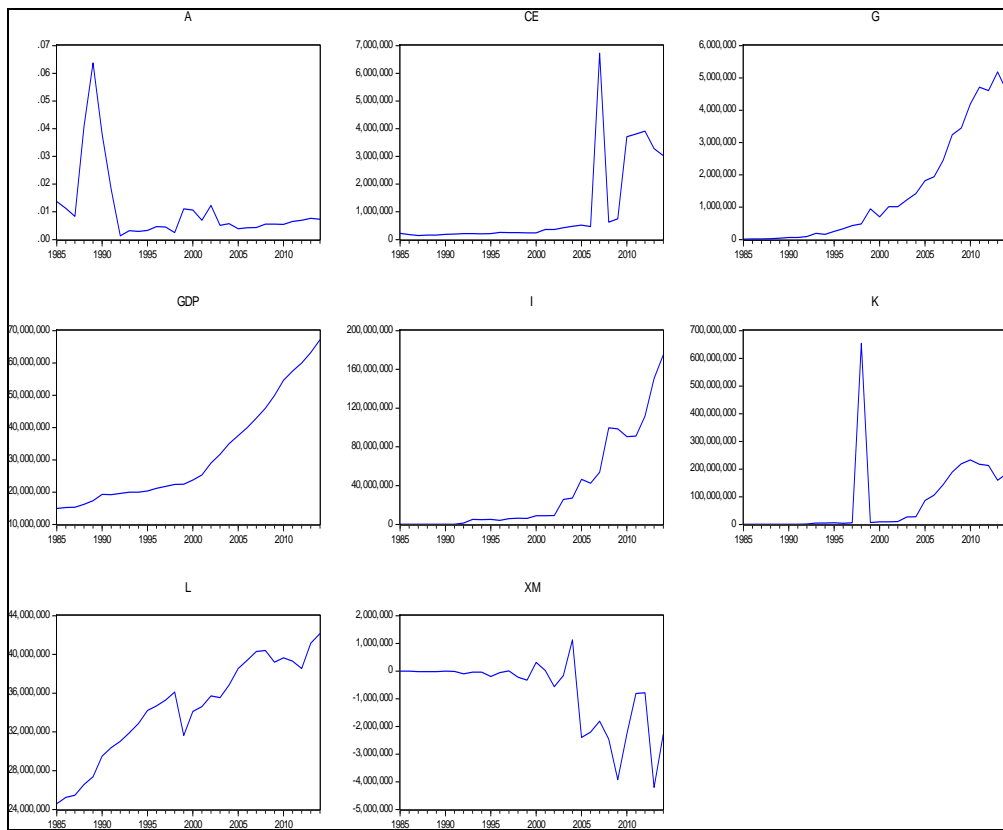
Appendices

1. Autocorrelation and Heteroscedasticity test for VECM (Real Business Cycle Model)

Source: author's computation using e-view 9 software

2. Autocorrelation and Heteroscedasticity test for ECM (Keynesian Model)

Source: author's computation using e-view 9 software

3. Graphic Trend of Variables

Source: author's computation using e-view 9 software