Simultaneous Equation Modeling and Estimation of Consumption and Investment Functions in Nigeria

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Abstract
The study applied simultaneous equation in modelling and estimating consumption and investment function in Nigeria. Specifically, the study ascertained the trend of study variables within the period of the study, established the effects of affluence on private consumption expenditure as well as determined the marginal propensity to consume, and determined the effects of interest rates and affluence on Domestic Private Investment. The study adopted the quasi experimental design, on time series data from 1983 to 2016. Models were specified accordingly, the data were subjected to diagnostic test before the main analytical techniques were applied. The OLS result of the private consumption expenditure Model was somewhat different from the 2SLS and the 3SLS results, the 2SLS, and the 3SLS results were identical. All results of the domestic private investment model were somewhat different, however, the 2SLS, and the 3SLS results agreed closely. It was observed from this study that standard errors in OLS results were less than their 2SLS and 3SLS counterparts. Affluence was significant in affecting private consumption expenditure within the period of the study (t-cal =7.485, 0.000 < 0.05), Previous year domestic private investment was not (t-cal =0.120, 0.9050 > 0.05). Affluence and previous year Affluence (t-cal = 8.962, 0.000 < 0.05) and (t-cal = -6.412, 0.000 < 0.05) significantly affected domestic private investment, interest rate however did not (t-cal = 1.164, 0.000 < 0.05). It was consequently recommended that right hand side variables should be tested for endogeneity before decision on single equation or system equation estimation. Since affluence significantly affected private consumption expenditure and domestic private investment within the period of the study, it was necessary to formulate policies to increase per capita income

Keywords: *Simultaneous Equation, Two Stage Least Squares (2SLS), Three Stage Least Squares (3SLS), Consumption function, Investment function.*

1.0 INTRODUCTION

Economic growth refers to a sustained increase in per capita output over a period of time. It results from increase in productive capacity and increase in capacity utilization of the economy leading to increased availability of goods and services in that economy. Economic growth is commonly measured using the Gross Domestic Product (the value of all final goods

and services produced in an economy within a given period) It is the monetary value of final output of the goods and services produce within the geographical confines of a country's territory in a given year (Adoghor, Onuchukwo and Ewubare 2008), and (Okidim and Tuaneh, 2012). The Nigerian GDP in 2016 was 481.2 billion (CBN, 2016). This does not exclusively reflect the true state of the citizenry as per capita income which is the measure of affluence per head in the same period stood at 2,548.2 US dollars which is about 7 USD/day. The question is; what then is individual's consumption given this affluence per head?

The concept of the study is based on the popular economic theory of consumption which states that consumption is a function of income ie. Income asserts positive influence on consumption (ceteris paribus), the researcher consequently, sought to look at this relationship more extensively and also in interaction with other variables.

C_t = Private Consumption at time t, A_t = Affluence (measure of income per head at time t)

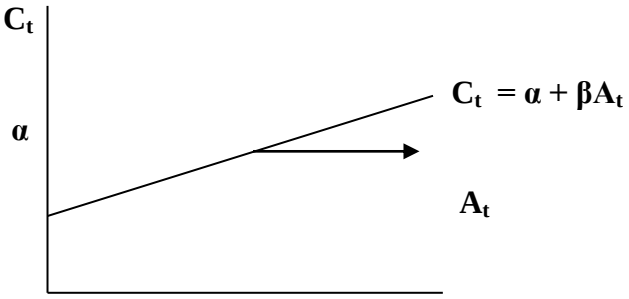

Figure: 1.1: Graphical illustration of the consumption function

α is the intercept in the consumption function and represent the autonomous level of consumption expenditure, **β** is coefficient which represent the marginal propensity to consume (mpc = ΔC/ΔY), thus total consumption expenditure is equal to the autonomous consumption and induced consumption expenditure (Ahuja, 2012).

But equilibrium income from a two sector economic model is given as Y = AD* = C + I. where Y = National income, AD* = aggregate demand, C = consumption demand and I = investment expenditure. (Ahuja, 2012)

Adapting from the macroeconomic concept above,

$C_t = f(A_t)$ 1.1.

$C_t = \beta_i A_t + U_t$ 1.2

$C_t = \beta_i A_t + e_t$ 1.3

$e_t = C_t - \beta A_t$ 1.4

Hence, $e_t'e_t = (C_t - \beta A_t)^1(C_t - \beta A_t)$ 1.5

$e_t'e_t = (C_t^1 - \beta^1 A_t^1)(C_t - \beta A_t)$ 1.6

$e_t'e_t = C_t^1 C_t - \beta^1 A_t^1 C_t - C_t^1 \beta A_t + \beta^1 A_t^1 A_t \beta$ 1.7

Since the transpose of a scalar is scalar $(C_t^1 \beta A_t)^1 = \beta^1 A_t^1 C_t$ 1.8

$e_t'e_t = C_t^1 C_t - 2\beta^1 A_t^1 C_t + \beta^1 A_t^1 A_t \beta$ 1.9

$\frac{de'e}{d\beta} = -2A^1 C_t + 2A_t^1 A_t \beta$ 1.10

At the turning point, $\frac{de'e}{d\beta} = 0$, hence,

$-2A_t^1 C_t + 2A_t^1 A_t \beta = 0$ 1.11

$2A_t^1 A_t \beta = 2A_t^1 C_t,$ 1.12

$\beta = (A_t^1 A_t)^{-1} A_t^1 C_t$ 1.13

1.12 is the unbiased estimator of β

Note: i = 0, 1, 2, …., k, t =1, 2, 3, ….. , n. k = Number of variables, n = Number of years).#, β_i are the parameter estimate, Consumption (C_t) is determined by the random explanatory and seeming Exogenous variable Affluence (A_t), if U_t, increases, C_t will also increase.

Simultaneity Bias;

Note that from 1.2 and 1.13 , $C_t = \beta A_t + u_t$ and $\beta = (A_t^1 A_t)^{-1} A_t^1 C_t$

Putting 1.3 in 1.12, $= (A_t^1 A_t)^{-1} A_t^1 (\beta A_t + u_t)$ 1.14

$= (A_t^1 A_t)^{-1} A_t^1 A_t \beta + (A_t^1 A_t)^{-1} A_t^1 u_t$ 1.15

$= \beta + (A_t^1 A_t)^{-1} A_t^1 u$ 1.16

Following one of the assumptions of the Ordinary Least Squares (OLS), E(u) = 0, then, E(β) = β, the application of the OLS holds, but if the assumption is violated [E(u) ≠ 0], it is clear from 1.16 that the E(β) ≠ β because the last term in 1.17 will not drop out, consequently, the model cannot be treated in isolation as a single equation model, This supports Brooks (2008), who asserted that the application of OLS to a structural equation which is part of a simultaneous system will lead to biased coefficient estimate and it is known as simultaneity bias Essi, Nafo, and Amadi (2010) explained that using Ordinary Least Squares (OLS) in estimating an equation gives and inconsistent estimate because of the correlation between and independent variable and the stochastic disturbance term. They further explained that in such a circumstance, it is likely that such an equation so estimated belong to a system. Unavoidably, a model describing a joint dependence of variables called simultaneous equation evolves. According to Koutsoyiannis (2003), the application of least squares in a single equation assumes among other things that the explanatory variables are truly exogenous, and consequently, there is one way causation between the dependent variable and the independent variable. If this is not true, that is A_t is also determined by C_t, one of the assumptions of the Ordinary Least Squares (OLS) is violated {E(u) ≠ 0}. The application of the OLS yields a bias and an inconsistent estimate.

Statement of the Problem

The problem is the concern that gives rise to a research study. Research works are consequently targeted at towards solving societal problems and based on the findings; proffer recommendations that are believed would reverse the undesired conditions. The springboard of this study is a succeeding observation.

System performance or structural relationships existing in systems are widely evaluated using single equation but the foregoing have shown however, that if the relationship is part of a series of inter-relationships simultaneously existing in the system, the application of the OLS to a single equation does not hold as it assumes that the explanatory variables are truly exogenous and that there is only one way causation between the dependent variable and the explanatory variables. Kousoyiannis (2003), there is consequently, the need to test for simultaneity bias before concluding on a single equation or a multiple equation. This study therefore, is an attempt to model a series of causal relationships existing among the study variables in the Nigerian economy using the simultaneous equation.

Objectives

The main thrust of this study is to apply the simultaneous equation in modeling estimating, within the context of the Nigerian economy, consumption and investment functions, 1983 - 2016. The specific objectives are to:

i. Ascertain the trend of, private consumption expenditure, affluence, domestic private investment, and interest rate.
ii. Compare the OLS, 2SLS and 3SLS results of the consumption and investment functions
iii. Establish the effects of affluence on private consumption expenditure as well as determine the marginal propensity to consume.
iv. Determine the effects of interest rates on domestic private investment.
v. Determine the effects of affluence on domestic private Investment.

Statement of the hypotheses

Ho_1 Private Consumption expenditure is not significantly influenced by affluence.
Ho_2 Domestic private investment is not significantly influenced by interest rate.
Ho_3 Domestic private investment is not significantly influenced by previous year affluence.
Ho_4 Domestic private investment is not significantly influenced by affluence.

Significance, Scope, and Limitation of the Study

The study is both informative and educative, it resolved the controversies concerning treating of a set of equations as single or structural equation. It also resolved the controversies concerning the choice of the estimators. The study re-establish the effects of the nation's wealth on the citizenry's consumption and investment, the applicability of simultaneous equation in structural modelling and has added to the existing statistical and macroeconomic/macroeconometrics literature for researchers and regulatory authorities.
This study covered a period of thirty four (34) years which spanned through (1983-2016) though references will be made to earlier and later dates as the need arise. The study covered the Federal Republic of Nigeria

The undue protocols involve in gaining access to information. Data from less developed countries are characterized by weakening of the database hence creating doubt on their usefulness in forecast and projection for policy. The improve service delivery of the NBS and the CBN have made available soft copies of statistical bulletin online for easy accessibility.

2.0 RELATED LITERATURE

Theoretical Literature

Empirical Framework

Private Consumption Expenditure and Affluence

(Alimi, 2013) examined the relationship between consumption expenditure and income in Nigeria in accordance with Keynes' Absolute Income Hypothesis (AIH) He used the ordinary least squares on the data covering the period of 1970-2011. He estimated MPC and APC in the short and long run found out that as income increases, the average propensity to consume was reduced as Keynes indicated but in the long run although MPC was unstable, it was however less than one.
(Ofwona, 2013), studied the relation between total household consumption expenditure and total income in Kenya for the period 1992 to 2011, he determined consumption function using Keynes's Absolute Income Hypothesis. He used the method of ordinary least square and found out that consumption was determined by income in Kenya in accordance with AIH.

(Nwabueze, 2009), examined the casual relationship between gross domestic product and personal consumption expenditure using the ordinary least squares regression analysis on data from Nigeria 1994 – 2007, She found out that an increase in gross domestic product had no significant effect on the personal consumption expenditure of Nigeria and the gross domestic product explained about 3.5% of the private consumption expenditure of Nigeria
(Sakib, 2011), investigated the causal relationship between consumption expenditure and economic growth in Bangladesh using Johansen and ARDL cointegration on annual data from 1976-2009. He found out that that there was cointegration between consumption expenditure and economic growth in the long run. The Granger causality revealed a long run unidirectional causal relationship running from economic growth to consumption expenditure.

(Mishra, 2011) studied the relationship between real consumption expenditure and economic growth in India using the cointegration test and the vector error correction regression for the years 1950-2008. The results showed that there was a long-run equilibrium relationship among the variables. The causality test in the error correction model revealed that there was a unidirectional causal relationship from real private consumption expenditure to economic growth in the long-run, however, in the short run Granger causality test indicated that there was no causality between them
(Akekere, and Yousuo, 2012), studied the effect of income changes on private consumption expenditure in Nigeria. They used the Ordinary Least Square simple regression analysis on data from 1981to2010. The results revealed that there was a positive impact of Gross Domestic Product on Private Consumption Expenditure with a slope of 0.6713 and it explains 98.4% of private consumption expenditure.
(Tapsin and Hepsag, 2014) carried out an analysis of household consumption expenditure in EA-18 using panel data from 2000 to 2012. The result from the Driscoll Kraay test indicated that some deviations from assumptions were corrected and meaningful results gained. Consequently, GDP was meaningful and positive on 99% trust level, more so, the study also showed that a 1 Dollar increase in GDP will increase the household consumption by 0.566 Dollar.

Domestic Private Investment and Affluence

(Patience and Osaro, 2010) in the assessment of trade and dynamics of the determinants of investment in Nigeria using the cointegration technique, they found that past outcome of domestic investment strongly influence the present level of investment in Nigeria. (Olusegun, 2010), examined the role of government in explaining domestic investment in Nigeria and found out from the long run estimation and impulse response that a well-structured and stable socio-economic environment boost domestic private investment over the long run.
(Lemi and Asifa, 2001), (Rasheed, 2005), and (Tawiri, 2010) in (Kalu, and Mgbemena, 2015) ascertained the link between domestic private investment and economic growth. There is obviously a growing literature on the link between domestic private investment and affluence; this according to (Baghebo and Edoummiekumo, 2012) is due mostly to the fact that developing countries are fond of formulating sound macroeconmic investment policies to attract investment even though the policies are later reversed.
(Bakare, 2011) examined the determinants of private domestic investment in Nigeria,he used the cointegration approach and the Error Correction Mechanism. The study showed that the political crisis may have created a climate hostile to positive investment in Nigeria.

METHODOLOGY

Research Design

This study adopted the quasi experimental design. This is used because the study seeks to find out the causes or effects relationship of the variables. The design becomes necessary because the issue for investigation is empirical, quantitative and analytical in nature and the variables are dependents and independents.

Types and Sources of Data

Time series data were used for the study. The researcher collected secondary data on, Affluence (Per Capita Income; Million Naira), Investment (Million Naira), Consumption (Million Naira) and interest rate (%) from reports and statistical bulletins of the Central Bank of Nigeria (CBN) and the Federal Bureau of Statistics. The choice of variables does not portray other variables ineffective, rather such variables appear to have higher correlation with the dependent variable

Methods of Data Analysis:

The main analytical techniques used are the econometric tools of multiple regressions, The Ordinary Least Squares (OLS), the Two Stage Least Square (TSLS) and the Three Stage Least Squares (TSLS) regression analysis

- ❑ Diagnostic Test:
- ✓ Test for Stationarity: Augmented Dickey-Fuller and The Phillips-Perron (PP) Unit Root tests
- ✓ Co-integration Test:
- ✓ Test for Simultaneity: Hausman specification test

Time series data are often non stationary, however, the assumption of stationarity of the regressors and the regressand are crucial for the adoption of the Least Squares estimators (Etuck, 2012). This is because the Stationarity of a series can strongly influence its behaviour, the use of non-stationary data can lead to spurious regression. Time series data on all variables included in the model are required to be stationary in order to carry out joint significant test on the lags of the variables. (Gujarati, 2013) explained that the various methods often used to test for stationarity; Augumented Dicky Fuller, the Phlilip Peron test, and the graphical method (the correlogram). The study however adopted the; Augmented Dickey Fuller and the Phillips-Perron Unit Root Test.

Augmented Dickey Fuller test is usually deployed in testing the unit root of a time series, say *X*. The test is the *t*-statistic on parameter α from the equations that follow:

$$\Delta C_t = \alpha_o + \alpha_1 C_{t-1} + \sum_{T=1}^{m} pi\, \Delta C_{t-T} + \mu_t \quad (3.1)$$

$$\Delta A_t = \alpha_o + \alpha_1 A_{t-1} + \sum_{T=1}^{m} pi\, \Delta A_{t-T} + \mu_t \quad (3.2)$$

$$\Delta I_t = \alpha_o + \alpha_1 I_{t-1} + \sum_{T=1}^{m} pi\, \Delta I_{t-T} + \mu_t \quad (3.3)$$

$$\Delta R_t = \alpha_o + \alpha_1 R_{t-1} + \sum_{T=1}^{m} pi\, \Delta R_{t-T} + \mu_t \quad (3.4)$$

Where Δ is the difference operator, U_t = random terms,
T = time trend, *M* = No of lagged differences,

ρ_i = Coefficient of the preceding observations, t-1 = Immediate past observation, Δ_{t-1} = Differenced lagged term, *M* = Number of lags, and **α** is the parameter to be determined,

The role of the lagged dependent variables in the augmented Dickey Fuller (ADF) regression Equations (3.1 - 3.3) is to ensure that U_t is white noise
The null hypothesis is that the series has a unit root 1(0), if 'α' is found to be more negative and statistically significant, we compare the *t*-statistic value of the parameter α, with the critical value tabulated in (MacKinnon, 1991), We reject the null and conclude that the series do not have a unit root at levels
The following unit root tests regression equations are used for the first-difference of the variables;

$$\Delta C_t = \alpha_o + \alpha_1 C_{t-1} + \sum_{T=1}^{m} pi\, \Delta^2 C_{t-T} + \mu_t \quad (3.5)$$

$$\Delta A_t = \alpha_o + \alpha_1 A_{t-1} + \sum_{T=1}^{m} pi\, \Delta^2 A_{t-T} + \mu_t \quad (3.6)$$

$$\Delta I_t = \alpha_o + \alpha_1 I_{t-1} + \sum_{T=1}^{m} pi\, \Delta^2 I_{t-T} + \mu_t \quad (3.7)$$

$$\Delta R_t = \alpha_o + \alpha_1 R_{t-1} + \sum_{T=1}^{m} pi\, \Delta^2 R_{t-T} + \mu_t \quad (3.8)$$

where the null hypothesis is I(2), that is, two unit roots which is rejected in favour of I(1).That is if 'α' is found to be negative and significantly different from zero.
The Phillips-Perron (PP) Unit Root tests**:**

The assumption of DF is that the error term u_t are independently and identically distributed. The ADF test adjusts the DF test to take care of possible serial correlation in the error term by adding the lagged difference terms of the regressand. Phillips and Perron use nonparametric statistical methods to take care of the serial correlation in the error terms without adding lag difference (Gujarati 2013).

Model Specification:
Structural Form of the Model
The model is specified in accordance with the concept of (Koutsoyianis 2003)

$C_t = f(A_t, I_{t-1})$ 3.9
$I_t = f(r_t, A_{t-1}, A_t,)$ 3.10
$A_t = C_t + I_t$ 3.11

The consumption, investment and Affluence, function in 3.9, 3.10, and 3.11 above are respectively written explicitly as;

$C_t = \Gamma_0 + \Gamma_1 A_t + \Gamma_2 I_{t-1} + U_{t1}$ 3.12
$I_t = \phi_0 + \phi_1 r_t + \phi_2 A_{t-1} + \phi_3 A_t + U_{t2}$ 3.13 A_t
$= C_t + I_t$ 3.14

Reduced Form of the Model

$C_t = \prod_{10} + \prod_{11} r_t + \prod_{12} A_{t-1} + \prod_{13} I_{t-1} + V_1$ 3.15
$I_t = \prod_{20} + \prod_{21} r_t + \prod_{22} A_{t-1} + \prod_{23} I_{t-1} + V_2$ 3.16
$A_t = \prod_{30} + \prod_{31} r_t + \prod_{32} A_{t-1} + \prod_{33} I_{t-1} + V_3$ 3.16

Matrix form

$Y = \prod + \prod^{*} X + V$

(nxg) (kng) (Kxg) (nxk) (nxg)

Where; A_t = Affluence (Per Capita Income) at time t

Y_t = Nation's Income (Government Revenue) at time t

I_t = Private Investment Expenditure at time t

C_t = Private Consumption Expenditure at time t

ϕ_0, Γ_0 = Intercepts

$\phi_1, \phi_2, \phi_3, \Gamma_1, \Gamma_2,$ = Regression coefficient

U_{t1} U_{t2} = Stochastic term

a' Priori Economic Expectation; Economic theory suggest the expected sign of the parameter estimate as; $\phi_1 < 0$, $\phi_2 > 0$, $\phi_3 > 0$, $\Gamma_1 > 0$, $\Gamma_2 > 0$

$$\prod_{10} = \frac{\Gamma_0 + \Gamma_0\Phi_3 + \Gamma_1\Phi_0}{1-\Gamma_1-\Phi_3} \qquad \prod_{11} = \frac{\Gamma_1\Phi_1}{1-\Gamma_1-\Phi_3}$$

$$\prod_{12} = \frac{\Gamma_1\Phi_2}{1-\Gamma_1-\Phi_3} \qquad \prod_{13} = \frac{\Gamma_2(1-\Phi_3)}{1-\Gamma_1-\Phi_3}$$

$$V_1 = \frac{U_{t1} + \Gamma_1 U_{t2} - \Phi_3 U_{t1}}{1-\Gamma_1-\Phi_3}$$

$$\prod_{20} = \frac{\Phi_0 - \Phi_0\Gamma_1 + \Phi_3\Gamma_0}{1-\Gamma_1-\Phi_3} \qquad \prod_{21} = \frac{\Phi_1(1-\Gamma_1)}{1-\Gamma_1-\Phi_3} \prod_{22}$$

$$= \frac{\Phi_2(1-\Gamma_1)}{1-\Gamma_1-\Phi_3} \qquad \prod_{23} = \frac{\Phi_3\Gamma_2}{1-\Gamma_1-\Phi_3}$$

$$V_2 = \frac{\Phi_3 U_{t1} + U_{t2} - \Gamma_1 U_{t2}}{1-\Gamma_1-\Phi_3}$$

$$\prod_{30} = \frac{\Gamma_0 + \Phi_0}{1-\Gamma_1-\Phi_3} \qquad \prod_{31} = \frac{\Phi_1}{1-\Gamma_1-\Phi_3}$$

$$\prod_{32} = \frac{\Phi_2}{1-\Gamma_1-\Phi_3} \qquad \prod_{33} = \frac{\Gamma_2}{1-\Gamma_1-\Phi_3}$$

$$V_3 = \frac{U_{t1} + U_{t2}}{1-\Gamma_1-\Phi_3}$$

4.0 RESULTS

4.1 Descriptive Statistics on all Variables

Table 1: Descriptive Statistics on Variables

	C_t	I_t	A_t	R_t
Mean	312.10	819.33	80.75	19.67
Median	239.25	129.18	33.59	18.05
Maximum	518.20	3215.48	211.61	36.10
Minimum	134.70	0.33	0.81	9.30
Std. Dev.	132.98	1138.90	85.42	6.21
Kurtosis	1.42	2.30	1.49	3.27
Observations	34	34	34	34

Source: Researchers computation

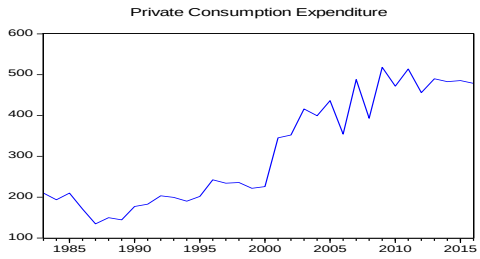

Figure 1: Time plot of Private Consumption Expenditure (C_t)

Figure 3: Time plot of Domestic Private Investment (I_t)

$C_t = 110.21 + 12.06\ T$

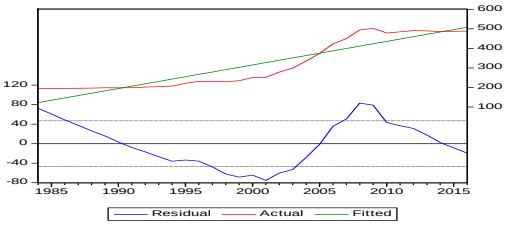

Figure 2: Trend plot showing the fitted, Actual and residual of Private Consumption Expenditure (C_t)

$I_t = -10.99 + 0.04\ T$

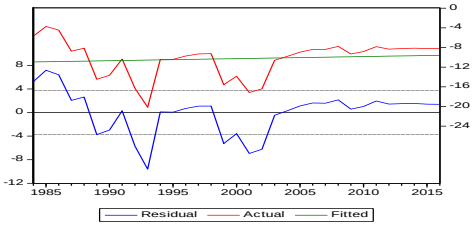

Figure 4: Trend plot showing the fitted, Actual and residual of Domestic Private Investment (I_t)

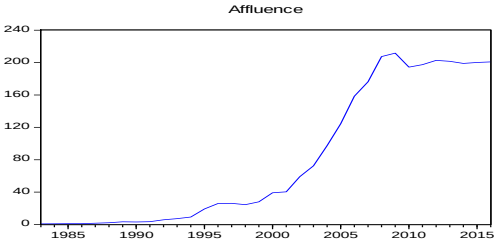

Figure 5: Time plot of Affluence (A_t)

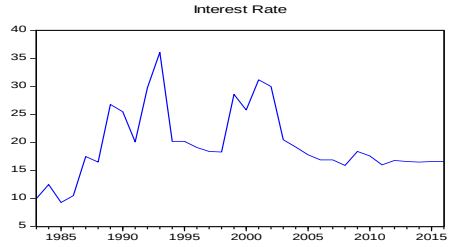

Figure 7: Time plot of Interest Rate (R_t)

$A_t = -50.17 + 7.93\ T$

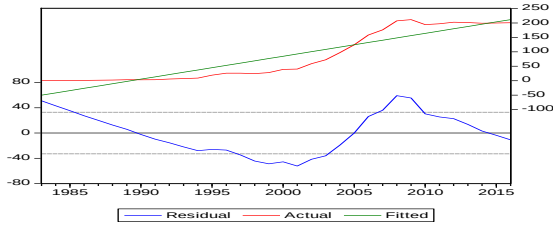

Figure 6: Trend plot showing the fitted, Actual and residual of Affluence (A_t)

$R_t = 19.88 - 0.01\ T$

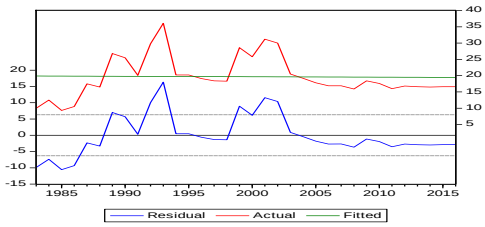

Figure 8: Trend plot showing the fitted, Actual and residual of Interest Rate (R_t)

The descriptive statistics of the study variables as shown on table 1 indicated that Private Consumption Expenditure (C_t) had an average of 312 billion Naira, the highest level of C_t within the period of the study is 518.2 billion Naira in 2009 and the lowest level is 134.7 billion in 1987. The study revealed that the most consistent periods for C_t was 6 years (1987-1992), C_t was however inconsistent within the period of the study. Figure 1 refers. However, the trend analysis shown in figure 2 indicated that the trend equation is; $C_t = 110.21 + 12.6\ T$. the series showed a linear trend. It is exciting to note that apart from differencing, another way to make a non-stationary series stationary is to regress it on time (trend analysis) and check the unit root of the residual from that regression

Table 1 also showed that Domestic Private Investment (I_t) had an average of 819 billion Naira, the highest level of I_t within the period of the study is 3215.48 billion Naira in 2010 and the lowest level is 134.7 in 1986. The trend analysis as also shown in the time plot of Domestic Private Investment (I_t) in figure 3 revealed that there was fluctuation in Domestic Private Investment (I_t) throughout the period of the study. However, the trend equation as shown figure 4 is; $I_t = -10.986 + 0.042T$.

Affluence which was measure by income per head showed from table 1, that its average value over the period of the study was 807.5 thousand Naira. The maximum value was 2116.1 thousand Naira in 2009 and the lowest value was 0.81 thousand obtained in 1984. Affluence appeared to be most consistent of all the variable considered, it showed a steady increase from for 7 periods (1883-1989), decreased in 1990, but increased for another 8 periods (1990-1997), decreased in 1998 but took off for 12 periods (1998-2009). The trend analysis shown in figure 6 indicated that the trend equation is; $A_t = -50.17 + 7.93T$, the series showed a linear trend.

Interest Rate (R_t) had an average of 19.67%, the maximum level within the period of the study was 36.10% obtained in 1993 and the lowest level was 9.30% in 1985 (time plot of Interest Rates (R_t) in figure 7 refers). A critical look at table 1 revealed that there was fluctuation in Interest Rates throughout the period of the study. However, the trend equation is as shown in Figure 8 is; $R_t = 19.88 - 0.01T$.

Diagnostic Analysis Result

The Unit Root Test (Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP)

Table 2: Summary of Stationarity (Unit Root) Test on all variables

Variables	Levels		1st Difference		2nd Difference		Order of
	ADF	PP	ADF	PP	ADF	PP	Integration
Private Consumption Expenditure (C_t)	-3.072	-3.619**	-11.779***	-10.742***			1(1)
Domestic Private Investment (I_t)	-1.702	-1.702	-5.722***	-5.722***			1(1)
Affluence (A_t)	-2.143	-1.899	-2.643	-2.590	-7.135***	-7.369***	1(2)
Interest Rate (R_t)	-3.179	-2.685	-6569***	-6.569***			1(1)

Source: Researcher' computation with Eviews 9.0, detail in appendix 7-24 Note: *, **, and *** represent significant at 10%, 5%, and 1% respectively

The study variables involved time series data, the Johansen technique cannot be applied unless it is established that the variables concerned are stationary. Data on each series were tested for stationarity so as to avoid the problem of spurious regression. For this study, the Augmented Dickey-Fuller (ADF) and Phillip-Perron test (PP) were used. Both tests test the null hypothesis of a unit root. The null hypothesis of a unit root is rejected in favour of the stationary alternative in each case if the test statistic is more negative than the critical value. A rejection of the null hypothesis means that the series do not have a unit root.

Table 2 presents results of the unit root tests. This results show that at levels, no Variable was more negative than the test statistics at 99% confidence hence the null hypothesis of a unit root were accepted.

Summarily, Augmented Dickey-Fuller and Phillips-Perron Test summarised in table 2 showed that: Private Consumption Expenditure, Domestic Private Investment and Interest Rate were all stationary at order 1(1) while Affluence was stationary at order 1(2),

Co-integration Test

Table 3: Summary of Johanson Co-integration Test on Private Consumption Expenditure (C_t) Model

Hypothesized	Eigenvalue	Trace	Crit. 0.05	Prob**	Max-Eigen	Crit. 0.05	Prob**
None*	0.5129	38.3084	29.7970	0.0041	21.5810	21.1316	0.0432
At most 1*	0.4173	16.7274	15.4947	0.0325	16.2024	14.2646	0.0244
At most 2	0.0173	0.5249	3.8414	0.4687	0.5249	3.8414	0.4687

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 4: Summary of Johanson Co-integration Test on Domestic Private Investment (I_t) Model

Hypothesized	Eigenvalue	Trace	Crit. 0.05	Prob**	Max-Eigen	Crit. 0.05	Prob**
None*	0.693314	46.93753	29.79707	0.0002	37.82174	21.13162	0.0001
At most 1	0.228919	9.115786	15.49471	0.3548	8.318759	14.2646	0.3472
At most 2	0.024599	0.797026	3.841466	0.3720	0.797026	3.841466	0.3720

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

After establishing stationarity, the next step is to test for cointegration because the long run combination of stationary processes can be non stationarity. The researcher consequently tested for co-integration using the Johanson Co-integration Test. Though trace statistic is said to be more robust to both skewness and excess kurtosis in residuals than the maximum-eigen value test, the Johansen maximum likelihood approach is said to be more referable to the other methods due to its properties (Wassell and Saunders, 2000) the researcher consequently used both maximum-eigen test and the trace statistics .

Co-integration Test Result on the Private Consumption Expenditure (C_t) Model

The Summary of Johanson Co-integration Test on Private Consumption Expenditure (C_t) Model in table 3 shows 2 co-integrating vectors. The table further revealed as follows;

HO_1: No co-integrating equation: Trace statistic of 38.31 > 29.80 critical value (PV = 0.004 < 0.05) Hypothesis of no co-integration is rejected. More so, the Max-Eigen statistics as shown in the same table 4.4 is 21.58 > 21.13 critical value (PV = 0.043 < 0.05) Hypothesis of no co-integration is rejected

HO_2: At most 1 co-integrating equation: Trace statistic of 16.73 > 15.49 critical value (PV = 0.03 < 0.05) Hypothesis of At most 1 co-integrating equation is rejected. Additionally, the Max-Eigen statistics as shown in table 4.4 is 16.20 > 14.26 critical value (PV = 0.024 < 0.05) Hypothesis of no co-integration is rejected

HO_3: At most 2 co-integrating equation: Trace statistic of 0.52 < 3.84 critical value (PV = 0.47 > 0.05) Hypothesis of At most 2 co-integrating equation cannot be rejected, consequently, there is at most 2 integrating equation. Furthermore, the Max-Eigen statistics as shown in table 4.4 is 0.52 < 3.84 critical value (PV = 0.043 < 0.05) Hypothesis of no co-integration is rejected. The result of the race statistic agrees with the Max-Eigen statistics in the Private Consumption Expenditure (C_t) Model.

The normalized co-integrating coefficients is:
Coin1 = $C_t + 1.76(R_t) - 0.24(A_t)$. Appendix 25 table 4.32 refers
SE in bracket s; (0.62) (0.04)

Co-integration Test Result on the Domestic Private Investment (I_t) Model

The Summary of Johanson Co-integration Test on domestic private investment (I_t) model in table 4 shows that both Trace statistics and the Maximum-Eigen Statistics indicate 1 co-integrating vectors.

HO_1: No co-integrating equation: Trace statistic of 46.94 > 29.80 critical value (PV = 0.002 < 0.05) Hypothesis of no co-integration is rejected. More so, the Max-Eigen statistics as shown in the same table 4.4 is 37.82 > 21.13 critical value (PV = 0.001 < 0.05) Hypothesis of no co-integration is rejected

HO_2: At most 1 co-integrating equation: Trace statistic of 9.12 < 15.49 critical value (PV = 0.35 > 0.05) Hypothesis of At most 1 co-integrating equation is accepted. Moreover, the Max-Eigen statistics as shown in table 4.4 is 8.32 < 14.26 critical value (PV = 0.34 < 0.05) Hypothesis of no co-integration is accepted. The result of the race statistic also agrees with the Max-Eigen statistics in the Domestic Private Investment model. The result however indicated one co-integrating equation. The normalized co-integrating coefficient is:

Coin1 = $I_t - 2.52\ (R_t) - 13.67\ (A_t)$.

SE in brackets; (4.87) (0.35)

4.3 Test of simultaneity (Hausman Specification Test)

Table 5: Summary of Regression Analysis showing the Effects of all exogenous variables on Affluence (A_t)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	2.2100	5.7778	0.3825	0.7049
RT	0.0098	0.2493	0.0392	0.9690
AT(-1)	1.2176	0.0423	28.7931	0.0000
IT(-1)	-0.0172	0.0032	-5.3913	0.0000
R-squared	0.9920	Adjusted R-squared		0.9912
F-statistic	1199.9540	Prob(F-statistic)		0.0000

Source: Researcher' computation with Eviews 9.0,

At = C(1) + C(2)*RT + C(3)*AT(-1) + C(4)*IT(-1)

At = 2.21+ 0.01*Rt + 1.22*At(-1) - 0.02*It(-1)

Table 6: Summary Regression Analysis showing the Effects of Affluence (Fitted) and the Residual (U_1) on Private Consumption Expenditure

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	193.5951	12.0625	16.0494	0.0000
$\hat{A}_t$	1.4456	0.2052	7.0445	0.0000
IT(-1)	0.0018	0.0158	0.1129	0.9109
U_1	1.9762	1.1044	1.7894	0.0840
R-squared	0.8844	Adjusted R-squared		0.8725
F-statistic	73.9748	Prob(F-statistic)		0.0000

Source: Researcher' computation with Eviews 9.0.

Ct = C(1) + C(2)* + C(3)*IT(-1) + C(4)*U1

Ct = 193.59 + 1.44 + 0.001 IT(-1) + 1.97U1

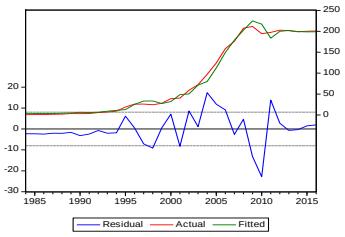

Figure 4.9 Graph of the Actual, Fitted and Residual Values of Affluence (A_t) from the first stage regression in the simultaneity test

Simultaneity Test Results

The test of simultaneity as explained in the methodology and analyzed above requires that the suspected endogenous variable is first regressed on all exogenous variables, the result functionally presented below

$A_t = 2.21 + 0.01R_t + 1.22A_t(-1) - 0.02\ I_t(-1)$

The second step requires that the dependent variable in the model (Private Consumption Expenditure) is regressed on the fitted values of the suspected endogenous variable (Affluence) and residual from the first stage regression and any other exogenous variable of that model. The summary of the result is shown in table 4.8 and functionally presented as

$C_t = 193.59 + 1.44\ \hat{A}_t + 0.001\ IT(-1) + 1.97U_1$
(12.063) (0.205) (0.015) (1.104)

The result revealed that the fitted affluence significantly affects private consumption expenditure (PV 0,000 < 0.05). Most importantly, the residual (U_1) significantly affects private consumption expenditure though at 10% level of significance (PV 0.084 < 0.01) consequently, Affluence is endogenous but only at 10% level of this agrees with Gujarati (2013). a 1% or even 5% level of significance would render Affluence exogenous.

Table 7: Summary of Regression Result from the Three Estimators

Models 1	OLS			Two Stage Least Square			Three stage least squares		
	Coef	Std, Error	t-Statistic	Coef	Std, Error	t-Statistic	Coef	Std, Error	t-Statistic
C	193.033	11.847	16.294	193.595	11.907	16.259	193.595	11.353	17.053
At	1.463	0.199	7.349	1.446	0.203	7.137	1.446	0.193	7.485
IT(-1)	0.0006	0.0154	0.038	0.002	0.016	0.114	0.002	0.015	0.120
	Ct = Dependent Variable								
Ct = 193.03 + 1.46At + 0.0006 It-1				**Ct = 193.60+ 1.45At + 0.002 It-1**			**Ct = 193.60 + 1.45*AT + 0.002*ItIt-1**		
	Squared (R^2)	0.883538		0.883508			0.883508		
	Adjusted R-squared	0.875774		0.875742			0.875742		
	S.E. of regression	47.15695		47.16316			47.16316		
Models 2									
C	3.322	154.395	0.022	34.133	166.636	0.205	-17.0777	150.439	-0.114
Rt	-1.696	6.643	-0.255	-1.311	7.141	-0.184	1.048	6.407	0.164
At(-1)	37.728	3.569	10.570	45.218	5.397	8.379	45.334	5.058	8.962
At	-24.465	3.498	-6.994	-31.873	5.313	-5.999	-31.930	4.9802	-6.412
	It = Dependent Variable								
It = 3.32 - 1.69Rt + 37.72A(t-1) - 24.46 At.				**It = 34.13-1.31Rt + 45.22A(t-1)-31.87At.**			**It = -17.08+1.05Rt+45.33*A(t-1)–31.93At**		
	Squared (R^2)	0.968430		0.963549			0.963336		
	Adjusted R-squared	0.965165		0.959778			0.959543		
	S.E. of regression	214.1458		230.1081			230.7788		

Source: Researcher' computation with Eviews 9.0

Private Consumption Expenditure Model

$C_t = 193.03 + 1.46A_t + 0.0006\ I_{t-1}$ OLS Result
$C_t = 193.60 + 1.45A_t + 0.002\ I_{t-1}$ 2SLS Result
$C_t = 193.60 + 1.45A_t + 0.002\ I_{t-1}$ 3SLS Result

The above result which is summarized in table 7 showed that there are sizeable difference between the single equation estimation and the structural or system equation estimation. The OLS result of the private consumption expenditure Model was somewhat different from the 2SLS and the 3SLS results, the 2SLS, and the 3SLS results were identical. This finding agrees with (Greene, 2008), and (Greene, 2012) on OLS, 2SLS, and 3SLS results, together with some other estimates.

The 2SLS and the 3SLS both had R^2 values of 0.883508, the R^2 is an indication of goodness of fit, the result though showed that 88.4% variation of private consumption expenditure was explained by variation in the explanatory variables. The remaining 11.6492% were explained by the contemporaneous error. The adjusted R^2 of 0.875742 and standard error of estimate of 47.163 were the same much like the functional representations above.

Domestic Private Investment Model

$I_t = 3.32 - 1.69R_t + 37.72A_{t-1} - 24.46\ A_t$ OLS Result
$I_t = 34.13 - 1.31R_t + 45.22A_{t-1} - 31.87A_t$ 2SLS Result
$I_t = -17.08 + 1.05R_t + 45.33A_{t-1} - 31.93A_t$ 3SLS Result

The above result which is also summarized in table 7 showed that there are sizeable difference between the single equation estimation and the structural or system equation estimation. All results of the domestic private investment model were somewhat different, however, the 2SLS, and the 3SLS results agreed very closely.

The parameter estimates of the OLS was more different, the 2SLS and the 3SLS agreed closely; the coefficient of affluence was -24.46 in the OLS model (one unit reduction in the affluence will increase domestic private investment by 24.46 unit) affluence had -31.87 and -31.93 in the 2sls and the 3sls respectively (one unit reduction in the affluence will increase domestic private investment by 24.46 unit). The coefficient of lag 1 of affluence was 37.72 in the OLS result while it showed 45.22 and 45.33 in the 2SLS and the 3SLS respectively.
The OLS showed R^2 of 0.968 and adjusted R^2 of 0.965. The 2SLS and the 3SLS both had R^2 values of 0.96, the adjusted R^2 of 0.96 and the standard error of Estimates were 230.1 and 230.8 respectively.

It is generally observed from this study that in the OLS result, levels of standard errors are less than their 2SLS and 3SLS counterparts consequently, by using OLS, one would come away with a false sense of the precision of the estimated structural coefficients, however, the biasness and inconsistency are obvious from the forgoing. This agrees with the findings of Gujarati 2013.

Though, the 2SLS and the 3SLS estimators have produced and identical results in the private consumption expenditure model and a very close result in domestic private investment model, the researcher tested the stated hypothesis with the 3SLS estimator. This choice is guided by the advantage of 3SLS estimator over 2SLS which basically is not only is it consistent, but in general it will be more efficient (asymptotically) than 2SLS, it takes into account the presence of the other equations in the model. This is done by recognizing that there will be a (contemporaneous) covariance structure between the error terms in each of the structural equations, the 2SLS estimator ignores this extra information.

The 3SLS and 2SLS results may be the same in some cases, this result from the same principle that causes OLS and Seemingly Unrelated Regressors (SUR) results to be identical unless an equation includes a regressor not used in the other equations of the system. When all the exogenous variables are used as instruments, linear combinations of all the exogenous variables appear in the third-stage regressions through substitution of first-stage predicted values. In this study, 3SLS produces different and more efficient estimates for the domestic private investment equation. However, the 2SLS and 3SLS results for the private consumption expenditure equation are identical. This may be because the consumption

equation had one endogenous regressor and one exogenous regressor not used in other equations. In contrast, the domestic private investment equation has fewer endogenous regressors than exogenous regressors.

The 3SLS had R^2 values of 0.963336, this is an indication of a good fit, the result though showed that 96.3336% variation of domestic private investment were explained by variation in the explanatory variables. The remaining 3.6664% were explained by the contemporaneous error. The standard error of estimate was 230.7788.

Results of Test of the Hypothesis

HO_1 Private Consumption expenditure is not significantly influenced by affluence

The summary result in table 4.9 and the detail result in appendix 33 table 4.40 showed that the coefficient of Affluence is 1.45 this implies that a one unit increase in affluence will increase private consumption expenditure by 1.45 unit.

The t-value of 7.49 had a corresponding significant value of 0.000 < 0.05, consequently, the researcher rejects the null hypothesis and conclude that affluence significantly affected private consumption expenditure within the period of the study.

The findings agreed with the findings of (Ofwona, 2013), who studied the relation between total household consumption expenditure and total income in Kenya for the period 1992 to 2011, using the method of ordinary least square and found out that consumption was determined by income in Kenya

HO_2 Private Consumption expenditure is not significantly influenced by previous year domestic private investment

Table 4.9 and the detail result in appendix 33 table 4.40 showed that the coefficient of previous domestic private investment was 0.002 and a t-value of 0.12 which had a corresponding significant value of 0.905 > 0.05, consequently, the null hypothesis cannot be rejected. it is concluded therefore that the previous domestic private investment does not significantly affect current of private consumption expenditure within the period of the study.

HO_3 Domestic private investment is not significantly influenced by interest rate.

The summary result in table 4.9 and the detail result in appendix 33 table 4.40 showed that the coefficient of Interest rate is -17.08 this implies that a one unit increase in interest rate will decrease domestic private investment by 17.08 unit.

The t-value of 6.41 had a corresponding significant value of 0.000 < 0.05, consequently, the researcher rejects the null hypothesis and conclude that interest rate significantly affected domestic private investment within the period of the study.

HO_4 Domestic private investment is not significantly influenced by previous year affluence

Table 4.9 and the detail result in appendix 33 table 4.40 indicated that the coefficient of previous affluence is 45.33 this suggests that a one unit increase in previous affluence will increase domestic private investment by 45.33 unit.

The t-value of 8.96 had a corresponding significant value of 0.000 < 0.05, consequently, the researcher rejects the null hypothesis and conclude that previous affluence significantly affected domestic private investment within the period of the study.

HO_5 Domestic private investment is not significantly influenced by affluence

Table 4.9 and the detail result in appendix 33 table 4.40 indicated that the coefficient of Previous Affluence is -31.93 this suggests that a one unit increase in affluence will decrease Domestic Private Investment by 31.93 unit.

The t-value of -6.41 had a corresponding significant value of 0.000 < 0.05, accordingly, the null hypothesis and it is concluded that affluence significantly affected domestic private investment within the period of the study. This agrees with the findings of (Patience and Osaro, 2010) that assessed trade and dynamics of the determinants of investment in Nigeria using the cointegration technique, and found that past outcome of domestic investment strongly influenced the present level of investment in Nigeria.
The test of hypotheses would have given the same result considering the t-values from other estimators.

5.0 CONCLUSION AND RECOMMENDATION

All the variables had unit root at levels. All the variables were made stationary at first difference 1(1) except affluence which was stationary at second difference 1(2). The Private Consumption Expenditure (C_t) indicated 2 co-integrating vectors while the Domestic Private Investment (I_t) indicated 1 co-integrating vectors. The simultaneity test conducted revealed the presence of simultaneity (affluence was an endogenous right hand variable) in the Private Consumption Expenditure (C_t) The OLS result was somewhat different from the 2SLS and the 3SLS results, the 2SLS, and the 3SLS results were identical. All results of the domestic private investment model were somewhat different, however, the 2SLS, and the 3SLS results agreed very closely. The parameter estimates of the OLS were however more different, the 2SLS and the 3SLS agreed closely

It is generally observed from this study that in the OLS result, levels of standard errors are less than their 2SLS and 3SLS counterparts consequently, by using OLS, one would come away with a false sense of the precision of the estimated structural coefficients, however, the biasness and inconsistency hare obvious from the forgoing.
Affluence was significantly affected private consumption expenditure within the period of the study while previous did not.
Domestic private investment was not significantly influenced by interest rate and affluence, it was however not affected by previous affluence

Recommendations

Right hand side variables should be tested for endogeneity before decision on single equation or system equation estimation.
At least two estimators (indirect least squares, two stage least squares, three stage least squares or full information likelihood) should be used in the data analysis and their results compared

Having seen that affluence significantly affected private consumption expenditure within the period of the study, it is necessary to formulate policies to increase per capita income
Interest rate significantly affected domestic private investment and with the right sign (negative) within the period of the study, consequently, interest rate should be reduced to increase domestic private investment.
Affluence significantly affected domestic private investment within the period of the study therefore and with the correct sign (positive), policies formulated to increase per capita income will affect domestic private investment positively

Contribution to Knowledge

Simultaneity test should be a key component of diagnostic test to be conducted on models before decision on single equation or system equation estimation.

Though it is often said that consumption is a function of income, the study has shown that income is not exogenous in its entirety even in this context.

The literature has shown that the advantage of 3SLS estimator over 2SLS is that it is not only consistent, but more efficient (asymptotically) than 2SLS, as it takes into account the presence of the other equations in the model which the 2SLS estimator ignores. However, the 2SLS and the 3SLS estimators have produced an identical results in the private consumption expenditure model and a very close result in domestic private investment model.

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