



EMPIRICAL ASSESSMENT OF THE VALIDITY OF HARROD-DOMAR GROWTH MODEL ON NIGERIAN ECONOMY

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Abstract

This paper is aimed at assessing the validity of Harrod-Domar Growth model on Nigerian economy from 1981 to 2015. The data sourced from CBN statistical bulletin, NBS and World Bank (2015). This work also applied various econometric methods of three unit root test, co-integration test, vector error correction mechanism to determine the relationship that between capital formation and Nigeria's economic growth. For co-integration test result, it was being revealed that the variables under consideration are co-integrated. The Granger causality test depicts independency between capital formation and economic growth. Based on VECM result that the variables are not contrary to economic a priori It is recommended, based on empirical discoveries, Nigerian government should employ fiscal and monetary instruments of increased government expenditure and reduced bank rate to establish equality between an increase in aggregate demand and the amount of net investment. Government should provide more infrastructures to incentivize domestic and foreign investors to set up business to produce more output, raise the level of income and at the same time helps in improving the people's living condition.

Keywords: Harrod-Domar, capital formation, econometric methods and economic growth.

JEL Classifications: E19, E22, C30, O40

Introduction

Any economy is aimed at achieving a sustained economic growth so as to raise the living standards of the people and reduce the high rate of unemployment. For a number of countries to have a sustained growth, there must be a huge investment in fixed capital assets (Ahuja, 2014). It is an indisputable fact that, there is a tradeoff between current consumption and future one. Depending upon the interest of a society; if a society is prioritizing future consumption, there must be a diversion of huge portion of its resources to the real sectors of economy to produce more goods and services that would be consumed by consumers in the future. This would accelerate the rate at which economy is growing. But if a society fails to accumulate more capital goods for future production, such kind of economy would necessarily face backwardness.

This would have a negative effect on economic growth (Jhingan, 2009). The growth performance of some third world countries of Africa and Latin America in 1950s and 1960s were quite impressive. The average of the annual GDP growth rates in these

countries was more than four times higher than that of Asia. However, by early 1970s, the four Asian Tigers of Hong Kong, Republic of Korea, Taiwan and Singapore had already caught-up and even went beyond of having income per-capita of 25% and 30% higher than that of Latin America and Africa respectively (World Bank, 1993). The poor performance of Africa and other third world countries between 1980s and 1990s could be traced to many distinct factors, of which is the low national saving and investment rates.

Based on the problems realized, the paper is intended to examine the relationship between capital formation (CF) and the level of economic growth in Nigeria. The paper is organized into four sections. Section one covers introduction, section two reviews the relevant literatures, section three present methodology and results and lastly, section four is concluding remarks.

Literature Review

There have been a considerable number of empirical researches on the relationship between capital formation and economic growth in less developed

countries, Nigeria inclusive. Shu'aib and Dania, (2015), while applying Harrod-Domar model to Nigerian economic development, finds significant relationship between capital formation and economic development in Nigeria. The results corroborated with the Harrod-Domar model which proved that the growth rate of national income will directly be related to saving ratio and/or capital formation. Among the variables used in the models were savings, investment and GDP as a proxy for economic growth. It is a well-known fact that Savings and investment are identical to one another especially from the classical point of view; it is a-theoretic to include them in the same model. Besides, GDP's behavior and that of economic growth are dissimilar, and on no account that one will surrogate one another. The same results are also obtained by Ugochukwu and Chinyere, (2013), using Ordinary Least Square technique and error correction mechanism. Though, this study failed to take into account the influence of consumer confidence, export and import on Nigeria's economic growth which is really pronounced. Kanu and Ozurumba, (2014) obtained similar result with Shu'aib and Dania, (2013) and Ugochukwu and Chinyere, (2013), using multiple regression technique and VAR. The results from these forgoing empirical studies are in conformity with economic a priori that exhibits direct relationship between capital formation and economic growth. Though, that of Kanu and Ozurumba, (2014) exhibited what is contrary to the theory in short run. Anyike and Kingsley, (2016) examined the factors that determine Nigerian capital formation applying Vector Error Correction Models. The Findings proved that Broad Supply, Gross National Savings, Exchange Rate, External Debt, Terms of trade have a negative and insignificant effect on capital formation while Credit to Private Sector, Lending Rate, inflation rate, Public Expenditure,

Government Revenue and Operating Surplus have positive and insignificant effect.

Adelakun and Babalola, (2015), while examining the determinants of savings and Investment in Nigeria using Error correction model, shows a positive relationship between savings, investment and economic growth in Nigeria. These findings were in line with that of Kalu, Joseph, Aniagolu and Obiora, (2014) and Jagadeesh, (2015). Jagadeesh, (2015) applied Harrod-Domar model based on Auto Regressive Distributed Lagged (ARDL) model and DOLS approach to check the existence of a long run relationship and co-integration between GDP and Gross Domestic savings in Botswana in the economy of Botswana. The empirical results revealed that, there is a significant relationship between Savings and economic growth in Botswana and the Harrod-Domar model is applicable to the economy of Botswana. In search of the stimulants of economic growth, a number of growth models have been developed. Therefore, Harrod-Domar growth model would be applied to capture the main objective of the research work.

Harrod-Domar Growth Model

Roy Harrod (1939) and Evsey Domar (1946) theorized their models of steady growth separately. Although, their models differed in details, but the underlying basic idea is similar. Harrod (1939) believed that, it is capital formation that plays crucial role in the development process.

Growth Equation

Capacity Effect of Investment (Supply Side)

The absolute increase in national output/income of an economy dy can be obtained from an increase in stock of capital dk multiplied by the national output produced by a unit of capital (Ahuja 2014). It is expressed in symbolic term as follows;

$$dy = dk * \frac{dy}{dk} \dots\dots\dots (1)$$

Thus, change in capital stock(dk) is but investment, therefore, I can be written in place of dk . And the

marginal output-capital ratio $\frac{dy}{dk}$ which is assumed to be constant and equal to average output-capital ratio $\frac{y}{k}$ can be denoted by θ .

$$\text{As therefore, } dy = I\theta \dots\dots\dots (2)$$

Capital-output ratio is but the amount of capital required to produce a desired level of output. Growth in income and capital should be expressed

as ratios of total income. For doing so, we divide both sides of equation (2) by y .

$$\text{Thus, } \frac{dy}{y} = \frac{I}{y} * \theta \dots\dots\dots (3)$$

$\frac{dy}{y}$ Represents the growth rate of output and is thus written as Gy .

Where, Gy = growth rate of output or income

$\frac{I}{y}$ = the rate of investment as ratio of national income

θ = Output-capital ratio

From the growth equation (3) above, it is clear that, given the output-capital ratio, the rate of growth of output depends on the rate of investment. The

greater the investment, the greater the growth rate of output or income. To maintain full employment equilibrium as economy grows at a steady rate, savings (S) must remain equal to investment (I), and symbolically written as;

$$Gy = \frac{S}{y} * \theta \dots\dots\dots (4)$$

$\frac{S}{y}$ represents ratio of savings to national output or income which is also called saving ratio, and be written as small letter s .

Thus, $Gy = s * \theta \dots\dots\dots (5)$

Equation (4) represents the supply side of the growth problem.

Demand Effect of Investment (Demand Side)

To achieve and maintain equilibrium, aggregate demand must be increased at a rate which is large enough to use the increased productive capacity which capital accumulation generates. To Keynes, increase in aggregate demand is given by an increase

in investment (dI) and the size of multiplier, i.e. $\frac{1}{s}$ where s is the MPS (assumed by Domar to be equal to the average propensity to save). Thus, according to demand or income effect of investment, the following is the equation;

$$dy = \frac{1}{s} * dI \dots\dots\dots (6)$$

Therefore, the aggregate demand or income increases at the rate of $\frac{1}{s} * dI$ where s is the propensity to save and dI is the absolute increase in investment. On the other hand, as shown by equation

(1) above, the increase in capacity output occurs at the rate of $I\theta$ where I is the absolute rate of investment and θ is the output-capital ratio. To maintain full employment equilibrium growth of output, the following condition must hold;

$$\frac{1}{s} * dI = I\theta$$

Or,

$$\frac{dI}{I} = s\theta \dots\dots\dots (7)$$

Where: $\frac{dI}{I}$ represents the rate of growth of investment. As seen above in equation (5), the rate of growth of income (Gy) is equal to $s\theta$, it follows that for equilibrium growth $Gy = \frac{dy}{y} = \frac{dI}{I} = s\theta$.

greater will be the growth of investment needed to maintain the steady growth with full employment. Similarly, the greater the value of output-capital ratio, i.e. θ , the greater will be the increase in income to avoid excess capacity. Hence, if income is to grow at a steady rate, investment must grow also at the annual steady rate given by $s\theta$. If sufficient growth in investment does not take place, steady growth cannot be achieved, i.e. when $\frac{dI}{I} < s\theta$. Hence, the relationship that exists between capital formation and economic growth would be shown in the upcoming regression equation form as:

Thus, the essential condition for maintaining a full employment equilibrium growth is that investment and real income (aggregate demand) must grow at a constant annual rate. This rate should be equal to the propensity to save (s) multiplied by output-capital ratio (θ), i.e. $s\theta$. It is evident from the basic equation $\frac{dI}{I} = s\theta$ that, the greater the saving rate (s), the

$$\% \Delta GDP = f(CF, HK, INFR, INTR, EXP, IMP) \dots\dots\dots (8)$$

The equation (7) is metamorphosed into a linear function as:

$$\% \Delta GDP_t = \beta_1 + \beta_2 CF_t + \beta_3 HK_t + \beta_4 INFR_t + \beta_5 INTR_t + \beta_6 EXP_t + \beta_7 IMP_t + \epsilon_t \dots\dots\dots (9)$$

Accordingly, equation (8) is the estimated one used in this research work.

Methodology

The research employed time series data that was sourced from CBN statistical bulletin and World Bank (2016) for different variables: GDP, capital formation, government expenditure on education as a proxy for human capital, export and import were sourced from World Bank (2016) while inflation rate and interest rate were sourced from CBN statistical bulletin (2016)

Analytical Tools

The analysis tested whether or not there is stationarity. For, or not the stationarity, Augmented Dickey Fuller (ADF), the Phillips-Perron and the De-trend Dickey-Fuller (DF-GLS) unit root tests were used There is a need to adopt Johansen co-integration analysis when the series are stationarised at first difference. After co-integration method,

$$\% \Delta GDP = f(CF, HK, INFR, INTR, EXP, IMP) \dots \dots \dots (10)$$

The equation (10) is metamorphosed into a short run econometric form as:

$$\% \Delta GDP_t = \beta_1 + \beta_2 CF_t + \beta_3 HK_t + \beta_4 INFR_t + \beta_5 INTR + \beta_6 EXP_t + \beta_7 IMP_t + \epsilon_t \dots \dots \dots (11)$$

The long run effects are captured with vector error correction mechanism (VECM).

$$\% \Delta GDP_t = \beta_1 + \beta_2 CF_t + \beta_3 HK_t + \beta_4 INFR_t + \beta_5 INTR + \beta_6 EXP_t + \beta_7 IMP_t + \beta_8 \% \Delta GDP_{t-1} + \beta_9 \% \Delta GDP_{t-2} + \epsilon_t \dots \dots \dots (12)$$

Where;

$\% \Delta GDP_t$ = percentage change in Gross domestic product

CF_t = capital formation

HK_t = Human Capital

$INFR_t$ = Inflation rate

$INTR_t$ = Interest rate

EXP_t = Export, IMP_t = Import, $T = Time$

ϵ_t = The error term assumed to be normally and independently distributed with zero mean and constant variance.

$$\% \Delta GDP_t = \beta_1 + \beta_2 CF_t + \beta_3 HK_t - \beta_4 INFR_t - \beta_5 INTR + \beta_6 EXP_t - \beta_7 IMP_t + \epsilon_t \dots \dots \dots (13)$$

Where:

$\beta_1, \beta_2, \beta_3, \beta_6 > 0$

$\beta_4, \beta_5, \beta_7 < 0$

Thus, the parameters such as $\beta_1, \beta_2, \beta_3$ and β_6 , according to the theory, are expected to be positive, i.e. greater than one. Whereas, the parameter estimates such as β_4, β_5 and β_7 are theoretically negative, i.e. less than one. This implies that CF, HK

Measurement of Variables

Percentage Change in GDP ($\% \Delta GDP_t$)

This paper used of percentage change in GDP as a surrogate to economic growth to explain the relationship that exists between economic growth

Vector Error Correction Model (VECM) has been employed to determine the speed of adjustment of the model. Lastly, Granger causality test to know the direction of causality between variables.

Model Specification

The essential condition for maintaining steady economic growth is that investment and real income (aggregate demand) must grow at a constant annual rate. It is deduced from the above equation (7) that, the greater the saving rate (s), the greater will be the growth of investment needed to maintain the steady growth with full employment. The nature and degree of the relationship between capital formation and economic growth can be expressed in mathematical form as:

β_1 is the constant term, while $\beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ and β_7 are the parameters of forgoing. It is rationale to clarify that, CF, HK (that's bring surrogated by government expenditure on education), EXP and IMP would be logged for simple computation and estimation.

A Priori Economic Expectations

Based on the economic a priori criteria, the expected signs of the parameter estimates of economic relationship of the model below are the following;

$and EXP$ are expected to exert positive influence on economic growth. On the other hand, other variables, such as $INFR, INTR$ and IMP that assume negativity exert negative influence on economic growth, that, they move in opposite directions.

and other factors that cause variability in it, especially capital formation.

Capital Formation (CF_t)

Capital Formation (CF_t) is a spending on fixed assets, such as building, tools, equipment and

machinery; either for replacing or adding to the stock of existing fixed assets. It is a component of the expenditure on gross domestic product (GDP).

Human Capital (HK_t)

The human capital stock measurement has been largely classified into the following; output based approach, cost based approach and income based approach. This paper is to make use of government expenditure on education, i.e. cost based approach, as a surrogate to the stock human capital.

Inflation (INF_t)

Inflation is a prevailing rise in the general level of prices of goods and services in an economy over a period of time. Inflation and economic growth rates are two important and most closely watched macroeconomic variables.

Interest Rate (INTR_t)

Interest rate is the price or cost of borrowing money from financial institutions over a given time period. A maximum lending rates or interest rate would

increase the cost of capital and therefore negatively affect private investment.

Export (EXP_t)

Export represents the total proceeds from the sale of goods and services from Nigeria to other countries. Thus, its coefficient is expected to be positive.

Import (IMP_t)

Imports represent the total cost of goods and services bought from another country for use to another country and its coefficient is expected to be negative.

Unit Root Test

The three unit root tests of Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP) and the De-trend Dickey-Fuller (DF-GLS) unit root tests are employed. For null hypothesis all the variables have the unit root. The tables that follow are the summary of ADF, PP and DF-GLS unit root tests for all variables respectively.

Table 1: ADF, PP and DF-GLS Unit root Tests: Level

Variables	ADF Test Stat	PP Test Stat	DF-GLS Test Stat	Critical Value at 1%	Order of Integration
% Change in GDP	-1.09	-0.90	-1.12	-2.63	Non-stationary
CF	-2.13	-2.21	-1.27	-4.25	Non-stationary
HK	0.57	0.46	-2.09	-4.25	Non-stationary
INFR	-2.71	-2.61	-2.79	-3.64	Non-stationary
INTR	0.56	0.26	-2.12	-2.64	Non-stationary
EXP	-0.98	-0.98	-1.40	-4.25	Non-stationary
IMP	-1.22	-1.97	-1.78	-4.26	Non-stationary

Source: Researcher’s computation from E-Views version 8.0.

Looking at the tables 1 the test statistics for all variables are lagging behind the critical values at 1% level of significance. These suggest non-rejection of null hypothesis and it is not surprising as most, if not all of the time series data often possess trends. Thus,

it becomes imperative to apply the three tests in order to stationaries the series. The outcomes of the aforementioned ADF, PP and DF-GLS unit root tests are presented in table 1.

Table 2: ADF, PP and DF-GLS Unit root Tests: at first difference

Variables	ADF Test Statistic	PP Test Stat	DF-GLS Test Stat	Critical Value at 1%	Order of Integration
% Change in GDP	-4.25	-4.25	-3.76	-2.64	I(1)
CF	-5.41	-6.21	-6.26	-4.27	I(1)
HK	-5.87	-5.93	-5.86	-4.26	I(1)
INFR	-5.35	-8.58	-5.05	-3.64	I(1)
INTR	-6.49	-8.05	-6.38	-3.65	I(1)
EXP	-4.91	-6.65	-5.91	-4.27	I(1)
IMP	-6.65	-6.67	-6.54	-4.26	I(1)

Source: Researcher’s computation from E-Views version 8.0.

The results from table 2 reveal that, all variables support the presence of a unit root at level and absence of any unit root at first difference, thus, they are integrated of order one I (1).

Choosing the Optimal Lag Length for a VAR Model

There are number of criteria such as *LR test*, *Final Prediction error*, *Akaike Information Criterion (AIC)*, *Schwartz Bayesian Criterion (SBC)* and *Hannan-Quinn (HQ) Information Criteria*.

These criteria are to be used in order to arrive at the optimal and most appropriate lag length. The foregoing criteria are in favor of the models with 2 lags in this analysis.

Co-Integration Test

The outcomes of co-integration test are obtained from both the *Trace statistic* and *Maximum Eigen statistic* in the tables 7 and 8 respectively.

Table 3: Co-integration Test Result for Trace Statistic

Hypothesis	Trace Statistic	Critical value at 5%	P-Value
None*	177.66	125.62	0.0000
At most 1*	106.45	95.75	0.0070
At most 2	63.68	69.82	0.1399
At most 3	34.72	47.86	0.4629
At most 4	17.03	29.80	0.0637
At most 4	6.66	15.49	0.6174
At most 5	0.85	3.84	0.3560

Trace test indicates 2 co-integrating equations at 5% level.

Source: Researcher’s computation from E-Views version 8.0.

Table 4: Co-integration Test Result for Max-Eigen Statistic

Hypothesis	Max-Eigen Statistic	Critical value at 5%	P-Value
None*	71.21	46.23	0.0000
At most 1*	42.76	40.08	0.0243
At most 2	28.97	33.88	0.1724
At most 3	17.69	27.58	0.5212
At most 4	10.37	21.13	0.7093
At most 5	5.81	14.26	0.6379
At most 6	0.85	3.84	0.3560

Max-Eigen value indicates 2 co-integrating equations at 5% level.

* denotes rejection of the hypothesis at 5% level.

Source: Researcher’s computation from E-Views version 8.0.

The results of co-integration test as presented in the tables 3 and 4 indicate that both the trace and maximum eigen statistics reject the null hypothesis of no co-integration and accept the alternative hypothesis that supports its presence at 5% level.

The results suggest evidence for the presence of two co-integrating vectors. Therefore, there is a dynamic and robust long run relationship between explained economic growth and capital formation.

Table 5: The Long-run Co-integrating Relationship Equation Result

Variable	DCF	DHK	DINFR	DINTR	DEXP	DIMP
%change in GDP	0.226	-1.621	-0.017	-0.038	-0.096	-0.216
	(0.077)	(0.403)	(0.002)	(0.007)	(0.125)	(0.110)

Source: Researcher’s computation from E-Views version 8.0.

The outcomes in table 5 show the linear relationship between explained variable and explanatory ones in Nigeria. It is of relevance to pin-point that human capital is having an inverse relationship with Nigeria’s economic growth in long run, likewise inflation rate and interest rate. Capital formation is the only variable that is affecting Nigeria’s economic growth in a positive way. All these findings are in conformity with economic a priori with an exception of that of human capital and

export whose parameters exhibits negativities. It is not surprising for human capital to move in an opposite direction with economic growth in the long run.

Vector Error Correction Model (VECM)

When the explained and explanatory variables are co-integrated, by definition $U_t \sim I(0)$, the relationship is going to be expressed with an ECM specification as:

$$\Delta Y_t = \beta_1 + \beta_2 \Delta X_t - \pi U_{t-1} + Y_t \dots\dots\dots (14)$$

This specification has an advantage of incorporating both short run and long run information. Therein, β_1 is the impact multiplier. On the other hand,

parameter π is the adjustment effect that shows how much of the distortion. The outcomes of VECM are obtained in table 10.

Table 6: Results of Vector Error Correction Model (VECM)

Variable	Coefficient	STD. Error	T-Statistic
D(DECM(-1))	-0.260	0.500	-0.510
D(D%GDP(-1))	-0.380	0.640	-0.59
D(D%GDP(-2))	0.120	0.54	0.230
D(DCF(-1))	0.140	0.180	0.790
D(DCF(-2))	0.010	0.210	0.040
D(DHK(-1))	0.120	2.070	0.06
D(DHK(-2))	-0.780	1.410	-0.550
D(DINFR(-1))	-0.002	0.007	0.280
D(DINFR(-2))	-0.001	0.006	-0.060
D(DINTR(-1))	-0.001	0.020	-0.060
D(DINTR(-2))	-0.009	0.010	0.640
D(DIMP(-1))	-0.190	0.260	-0.700
D(DIMP(-2))	-0.110	0.190	-0.610
D(DEXP(-1))	0.050	0.210	0.220
D(DEXP(-2))	0.080	0.170	0.440
C	-0.040	0.050	-0.690

R-Squared 0.55
 Adjusted R-Squared 0.10
 F-Statistic 1.22

Source: Researcher’s computation from E-Views version 8.0.

The ECM result, as presented in table 6 happens to have the expected negative value (-0.26) which is correctly signed, but not statistically significant at 5% level in correcting for the short run disequilibrium. Thus, the Nigerian economic growth is able to adjust itself and move towards equilibrium. This speed of adjustment suggests that about 26% of

the preceding period’s distortion in the economy is corrected every year. The implication is that it will take approximately four years for any disequilibrium in the economy caused by independent variables to be corrected. The estimated model in the long run is given as:

$$\% \Delta GDP_t = -0.04 - 0.140CF_t + 0.120HK_t - 0.002INFR_t - 0.001INTR_t + 0.050EXP_t - 0.190IMP_t - 0.380\% \Delta GDP_{t-1} + 0.1206\% \Delta GDP_{t-2} + U_t \dots\dots\dots(15)$$

Residual Tests

The outcomes of diagnostic tests for serial correlation, normality and heteroskedasticity are obtained in table 11.

Table 7: Diagnostic Test Results

Test	Stat./Chi-Sqr	P-Value
Normality Test	130.0764	0.2143
Correlation Test	49.17593	0.4661
Heteroskedasticity Test	339.4701	0.3479

Source: Researcher’s computation from E-Views version 8.0.

The results of diagnostic tests in the table indicate that, the probability values of all the diagnostic tests happen to be greater than 0.05. As for the normality, the probability value is put at 0.21 that of serial correlation is 0.47 while the probability value of

heteroskedasticity is 0.35. The foregoing results imply that, null hypotheses are to be accepted and conclude by having a best model whose residuals are normally distributed, un-correlated and homoskedastic.

Granger Causality Test

Table 8: Granger Causality Test Results

Null Hypothesis:	Obs.	F-Stat.	Prob.
% Δ GDP not granger cause CF	32	0.78828	0.4648
CF not granger cause % Δ GDP		0.41606	0.6638
% Δ GDP not granger cause HK	32	0.38956	0.6811
HK not granger cause % Δ GDP		1.29706	0.2848
% Δ GDP not granger cause INFR	32	7.15291	0.0032
INFR not granger cause % Δ GDP		0.47981	0.6241
% Δ GDP not granger cause INTR	32	1.24028	0.3053
INTR not granger cause % Δ GDP		1.94066	0.1631
% Δ GDP not granger cause IMP	32	3.49951	0.0445
IMP not granger cause % Δ GDP		0.16261	0.8508
% Δ GDP not granger cause EXP	32	3.57437	0.0420
EXP not granger cause % Δ GDP		0.21237	0.8100

Source: Researcher's computation from E-Views version 8.0.

Based on the results presented on table 8, the null hypothesis of no Granger causality between capital formation and economic growth in Nigeria is to be accepted. Thus, none of the two that Granger causes one another. The reason for this acceptance is because of having P-values that are greater than 5%, i.e. 46% and 66% respectively. It is evident to pinpoint also that, economic growth Granger causes inflation rate, but inflation rate does not Granger cause economic growth at 5% level of significance. Therefore there is unidirectional causality from economic growth to inflation". Also so import and export do the like Thus, there is a unidirectional causality from economic growth to inflation, unidirectional causality from economic growth to import and unidirectional causality from economic growth to export.

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