PUBLIC CAPITAL INVESTMENTS AND SUSTAINABLE ECONOMIC DEVELOPMENT IN A DEPRESSED ECONOMY: FOCUS ON NIGERIA

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ABSTRACT

This paper applies the Bounds test under the ARDL model approach to cointegration to investigate the relationship between public capital investments and real gross domestic product. public capital investments is decomposed into capital investments in administration, economic, social and community services as well as transfer services, while sustainable economic development is measured by Real Gross Domestic Product. Empirical results show that there is a long run relationship between public capital investments and economic development. Furthermore, the long run form tests, through the error correction term, indicate that public capital investments have a causal effect on economic development. In addition, the result of the forecast evaluation on Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error, Thiel Inequality Coefficient, Bias Proportion, Variance Proportion, and Covariance Proportion show that economic development can be predicted using public capital investments variables of capital investments in administration, economic, social and community as well as transfer services. The study therefore concludes that public capital investments promote economic development in Nigeria. The study recommends increasing capital investments in social and community services (education and health) as it has proved to be beneficial to economic development through human capital development. On the other hand, capital investments in transfer services should be minimized as it negatively affects RGDP. Furthermore, capital investment in economic services should be re-examined to identify possible leakages that negate its effect on Real GDP against apriori expectations.

Keywords: Public Capital Investments, Sustainable Economic Development, ARDL

INTRODUCTION

In the book "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (World Bank 2011), development is seen as a process of building and managing a portfolio of assets. It goes on to say that the challenge of development is to manage, not just the total volume of assets, but also the mix of the asset portfolio, that is, how much to invest in different types of capital; natural, human and productive assets as well as the institutions and governance that constitute social capital. Resource managers must therefore make conscious decisions about how much to invest and particularly what mix of assets to invest in. Thus, the consideration for how much to invest and what mix of assets to invest in is very crucial towards the attainment of sustainable economic development. In Nigeria, there is little evidence to show that the distribution

of public capital investments in administration, economic, Social and community services as well as transfers services have attracted reasonable attention from the managers of Nigeria's sources of wealth. This is evident in the neglect or minimal investment or lack of resolve to invest in productive assets, build and strengthen institutions, as well as social capital and governance systems frequently referred to as intangible capital which have been shown to possess the key to sustainable development when eventually natural resources are exhausted. Intangible capital includes human, social, and institutional capital, and several other "unaccounted-for factors" that contribute to human well-being. It makes up a large share of total wealth, an estimated 60–80 percent in most developed countries", (World Bank 2006, 2011). *Where Is the Wealth of Nations?* (World Bank, 2006) shows that education (human capital) and the rule of law (social capital) accounted for most of the intangible capital of developed nations. Thus, a proper mix of Investments is critical in public capital investments for sustainable development. According to Musgrave and Musgrave (1989), a fundamental requirement of economic development is an adequate rate of capital formation relative to that of population expansion. Such capital formation surely takes the form of investments in natural, human, social and institutional capital that do not upset the natural balance of ecosystems and biodiversity, both for the good of the present and future generations. Thus, managing public capital investments in a portfolio or integrated concept ensures that the right mix of investments in the respective capital components can help make current economic, social and environmental practices more sustainable.

This paper examines the composition and trend of investments in administration, economic, social and community services as well as transfers services over time as well as their relationship with and impact on sustainable economic development. Most researches dealing with resource components dwell on the proper use of resources, especially natural resource and almost always find it difficult to avoid clichés like "resource curse", "Dutch disease" as well as reference the Hartwick Rule on "Resource Rents" to point the route to better wealth accumulation. This study is not about these but is about the right mix of resource components, indeed an optimal mix that would yield the highest attainable and sustainable Economic Development. We ask the question whether the composition and proportion of public capital investments over the years in administration, economic, social and transfers services have led to sustainable economic development. Following the above introduction, section two explores related literature. Section three details the methodology employed and in section four we present the empirical analysis of data and results. Finally, in section five, we present the conclusions and recommendations.

REVIEW OF RELATED LITERATURE

The Concept of Sustainable Development

Until 1987, Sustainable and Development were two separate words provoking different meanings to different people. But by 1987, The World Commission On Environment and Development (WCED) convened by the United Nations (UN) in 1983 and chaired by the Norwegian prime minister, Gro Harlem Brundtland, in their report "Our Common Future," also called

'the Brundtland report,' coined and popularized the most often-quoted definition of sustainable development. The commission defined sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, P.45).

Sustainable Development is also a term used to encapsulate an integrated vision for progress that links economic development, protection of the environment and social justice. According to the Canadian International Development Agency (CIDA), Sustainable development is both a journey - a process of continuous improvement towards the end point where human kind has learned to live sustainably on this planet - and a framework within which a balance can be achieved between the wealthy and the poor (both within a country and between rich and poor nations) and between the interests of this generation and future generations.

Sustainable development also emphasizes on factors that affect everyday life, such as, health, employment opportunities, access to services and the quality of transport infrastructure as well as sense of well-being. Sustainable development is about pursuing simultaneously and with equal vigour, economic, social and environmental benefits in a fully integrated manner. Therefore, in managing the natural, produced, and social capital for the welfare of present and future generations, there has to be measurable statistics or mile stones upon which sustainable development can be said to have been achieved. According to the International Institute for Sustainable Development (IISD), there are over a hundred indicators in use for measuring sustainable development. Headline indicators include but are not limited to:

(*1) Socio- economic – with growth rate of real GDP per capita as the operational measure.*
(2) Sustainable consumption and production – captured by resource productivity.
(3) Social inclusion, as measured by people-at-risk-of poverty.
(4) Demographic changes. as it relates to employment rate of old workers.
(5) Public health, as captured by healthy life years and life expectancy at birth.
(6) Sustainable transport, as in energy consumption of transport relative to GD.P
(7) Climate change monitored through: (a) Greenhouse emission, (b) share of renewable energy in gross final energy consumption and (c) primary energy consumption.
(8) Natural resources – total resource rents
(9) Global partnership measured by Official Development Assistance (ODA) as share of gross national income
(10) Good governance – openness and accountability……

The above list is by no means in order of importance and as has already been indicated, there are over a hundred indicators in use. The scale of importance therefore is determined by the priority of need and prevailing circumstance of a particular nation. With these sustainable development objectives in mind, resource managers are therefore in no position to be envied. The task of managing the nation's resources for sustainable development is daunting, challenging, and demanding. Nevertheless, CIDA believes it can be done and advocates investments that support equitable economic and social development, environment and natural resources management as well as progress in democratic governance.

ECONOMIC, HUMAN, SOCIAL CAPITAL AND SUSTAINABLE ECONOMIC DEVELOPMENT

According to the International Institute for Sustainable Development (IISD), there are three pillars of sustainable development – economic capital, social capital and environment capital. But Goodwin (2003) identifies Five Kinds of Capital; financial, natural, produced, human, and social capital and called them 'Useful Concepts for Sustainable Development'. On the other hand, Radej (2007), in the paper, **'**The Four Capital Model, Matrix and Accounts,' admits just the economic, social, human and natural capital components.

From Nigeria's capital expenditure classifications, four capital components can be identified and these are administration, economic, social and human, -though social and human may be listed together -and transfers. According to Giraud and Loyer (2006), social capital is often difficult to distinguish from human capital.

Human Capital consists of people's health, knowledge, skills and motivation. All these things are needed for productive work. Enhancing human capital through education and training is central to a flourishing economy. Social Capital concerns the institutions (e.g. Judiciary) that help maintain and develop human capital in partnership with others. Education is a basic component of open, democratic and equitable societies, and essential for sustained social and economic development. Basic education and the acquisition of skills and knowledge are understood to be a main driver in reducing poverty and in sustainable development. Education is a transformative change agent, empowering individuals to contribute to their own social and economic well-being and to that of their communities.

Ensuring good health status for the world's population is key to laying the foundation for sustainable social, economic, and human development. Democratic governance is essential for reducing poverty and for long-term sustainable development in developing countries. It is also essential for national, regional, and global stability, and helps ensure security and prosperity in an interdependent world.

PUBLIC CAPITAL INVESTMENTS

Governments invest for two primary reasons: Firstly, investment may be required to replace worn out, or failing machinery, equipment, or buildings. This is referred to as *capital consumption,* and arises from the continuous depreciation of fixed capital assets. Secondly, investment may be undertaken to purchase new machinery, equipment, or buildings in order to increase productive capacity. Gross investment includes both types of investment spending, but net investment only measures *new* assets rather than *replacement* assets. In economic theory, net investment carries more significance as it provides the basis for economic growth. In macroeconomics, the investments of national economies is measured by Gross capital formation which is defined in the System of National Accounts (SNA) as the total value of gross fixed capital formation plus changes in inventories and acquisitions less disposal of valuables. Gross fixed capital formation is the total value of produced assets used in the production process for more than one year. Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential

dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation (World Bank national accounts data and OECD National Accounts data files).

In Nigeria, the Federal government capital investments are distributed between four component services.

1. Administration which consists of General Administration, Defence, Internal Security and National Assembly.
2. Economic Services comprising Agriculture, Construction, Transport & Communication, Other economic services
3. Social and Community Services with Education, Health as well as other social and community services components
4. Transfers made up of Public debt servicing, Pensions and gratuities, Contingencies/subventions, and other charges.

THEORETICAL CONSIDERATION

Keynes' Theory of Savings/ Investment

According to Keynes (1936), savings is determined by income since savings is the excess of income over expenditure on consumption It is a 'psychological law' that when peoples' incomes increase, they increase their savings to such an extent that the saved share of their incomes increases which is made available for investment. This putative law was rooted in empirical observations of savings in various income groups, and Keynes concluded that, in a period of economic growth, the share of national income that constitutes aggregate savings steadily rises.

Keynes also emphasized that current investment is equal to the value of that part of current output which is not consumed; and saving is equal to the excess of income over consumption; also that the amount of saving is an outcome of the collective behaviour of individual consumers and also, the amount of investment is an outcome of the collective behaviour of individual entrepreneurs; these two amounts are equal since each of them is equal to the excess of income over consumption. Thus,

Income = Value of output = Consumption + Investment

Investment = Income – Consumption

Saving = Income – Consumption

Therefore,

Saving = Investment

Income is created by the value in excess of user cost which the producer obtains for the output he sold either to a consumer or to another entrepreneur; and each entrepreneur's current investment is equal to the excess of the equipment which he has purchased from other entrepreneurs over his own user cost. Thus, Keynes maintained that on the aggregate, the excess of income over consumption (savings) cannot differ from addition to capital equipment (i.e. Gross Domestic Investment) due to the rate of interest which is a factor that brings the demand for investment and the willingness to save into equilibrium with one another.

HARROD-DOMAR GROWTH MODEL

According to Nnamocha, Echeta and Anyadike (2017), the Harrod-Domar model is an early post Keynesian model of economic growth. Harrod and Domar extended the Keynesian analysis of income and employment to long run setting and therefore considered both the income and capacity effect of investment. The model explained at what rate investment should increase so that steady growth is possible in an advanced capitalist economy. It explains an economy's growth rate in terms of the

level of savings and productivity of capital. Thus, it states that the rate of economic growth in an economy is dependent on the level of savings and the capital output ratio. This means that every economy must save a certain proportion of its national income in order to replace worn out capital goods such as building, equipment and materials. Also, for the nation to grow, new investments representing net additions to the capital stock are necessary. Thus, if there is a higher level of saving in a country, it provides funds for firms to borrow and invest. Investment can increase the capital stock of an economy and generate economic growth through the increase in production of goods and services. The capital output ratio measures the productivity of the investment that takes place. If capital output ratio decreases, the economy will be more productive, so higher amount of output is generated from fewer inputs. This again leads to higher economic growth. Thus, the model is as stated below:

Rate of growth (ΔY/Y) = National saving ratio (s)/Capital-output ratio (k)

Where:

National savings ratio (s) is the ratio of total savings to national income. It is assumed that total saving is directly proportional to national income. Therefore, it is that proportion of the national income that is saved for investment purposes.

The main obstacle to development, according to the Harrod-Domar model, is the relatively low level of new capital formation in most developing countries. Thus, the capital constraints stages of approach to growth and development became a rationale and an opportunistic tool for justifying massive transfers of capital and technical assistance from the advanced economies to less advanced economies.

SOLOW GROWTH MODEL

Solow growth model (1956) made use of variable proportion production function. It considers unlimited possibilities of substitution between capital and labour in the production process. In this way, it addresses the accumulation of capital (i.e. savings and investment). The model is designed to show how growth in the capital stock, growth in the labour and advances in technology interact with an economy and how they affect a nation's total output of goods and services. Hence, its attention is focused on the supply side factors such as capital and technology for determining rate of economic growth of a country. The Solow model assumes that each year, people save a fraction of their income and consume a fraction. According to this model, the growth of output is achieved at least in the short run through higher rate of saving and therefore higher rate of capital formation. If planned saving is greater than the required investment to keep per capita income constant, capital per worker will increase. This increase in capital per worker will cause increase in productivity of worker. As a result, the economy will grow at higher rate than the steady state equilibrium growth rate.

EMPIRICAL FRAMEWORK

Several studies have engaged in finding the impact of capital components individually or collectively on economic growth. But few have examined the composition and mix of capital components in relation to sustainable economic development.

Omotayo, Olajide and Abidemi (2015) investigated "human capital development and economic growth in Nigeria using time series data from 1980 to 2012 under the ordinary least squares regression framework

and found that human capital significantly affect gross domestic product in Nigeria.

Nkogbu (2014) in a research on "enhancing sustainable economic growth and development through human capital development in Nigeria" used primary data collected from 296 respondents and analyzed using simple percentages, mean score and chi-square, found that investment in human capital development results in improved economic growth and development at the 5% level of significance.

Adelowokan (2012) studied "growth effects of education and health expenditure in Nigeria for the period, 1970 to 2010. Applying a static regression model and Engle-Granger two step cointegration tests, the results show that public investment and public consumption in education and health exert positive influence on economic growth. The results further show that there is a long-run relationship between economic growth and expenditure on education as well as health in Nigeria.

Oluwatobi and Ogunrinola (2011) worked on Government Expenditure on Human Capital Development: Implications for Economic Growth in Nigeria. Their study examined the relationship between human capital development efforts of the Government and economic growth in Nigeria and they explored the impact of government recurrent and capital expenditures on education and health in Nigeria and their effect on economic growth. Data used for the study were from secondary sources, while the augmented Solow model was adopted. The dependent variable in the model was the level of real output, while the explanatory variables were government capital and recurrent expenditures on education and health, gross fixed capital formation and the labour force. The result showed that there exists a positive relationship between government recurrent expenditure on human capital development and the level of real output, while capital expenditure was negatively related to the level of real output. The study recommended appropriate channeling of the nation's capital expenditure on education and health to promote economic growth.

Ditimi and Nwosa (2011) studied investment in human capital and economic growth in Nigeria, 1970 to 2009 using Vector Error Correction (VEC) and Pairwise granger causality methodologies. Co-integration test result revealed the absence of co-integration between Investment in human capital and economic growth. The findings of the VAR model and pairwise estimate revealed no causality between human capital development and economic growth. Kaasa and Parts (2008) studied 'human and social capital as interacting factors of economic development: evidence from Europe.' The study covered a national sample that included 28 European countries for the period, 1999 – 2007 and a regional sample of 160 regions from 19 countries for the period 1999 – 2005. Applying Factor and Regression analysis, the results show that human and social capital cross effects affect economic development. At the regional level, synergy between human and social capital affects gross domestic product per capita changes and growth rates.

Awe and Ajayi (2010) examined the nexus between human capital investment and economic growth in Nigeria. Specifically their study investigated the causality between human capital investment and economic growth during the period, 1975-2005, using cointegration and Error Correction Mechanism (ECM). They found that there

exists a directional causality between Human Capital Investment and Economic Growth in Nigeria and recommended that government should increase its budgetary allocation to the education and health sectors, coupled with concerted efforts of all the stakeholders: government at levels, non-governmental organizations and the organized private sector in improving educational and health facilities for sustainable economic growth.

The World Bank (2006), "Where Is the Wealth of Nations" and the World Bank (2011), "The Changing Wealth of Nations" used a number of countries, classifying them into high, middle and low income countries and estimated what their total wealth would be following the Hartwick rule. The results show that human, social, and institutional capitals make up a large share of total wealth, an estimated 60–80 percent in most developed countries. This present study departs from the World Bank studies as it does not pretend to estimate what the total wealth of Nigeria would be following the Hartwick rule but examines the extent to which the composition and mix of public capital investments have contributed to sustainable economic development.

METHODOLOGY

Now, whether there are three pillars, four capital model or Five Kinds of Capital, the challenge is how to combine and coordinate these in an integrated manner for Sustainable development. This concern finds expression in Radej (2007) who writes that **i**n order to equalize growth opportunities for all forms of capital, policy makers need empirical and analytically rigorous tools to present interactions between capitals as multiple and parallel. Earlier, Ekins and Medhurst (2003) had used the combined quantitative-qualitative methodology of 'sustainability assessment framework' that is derived from impact assessment methodology to examine the interactions among wealth components. But Radej (2007) proposed a more orthodox formulation which at first transforms the sustainability assessment framework into the standard Leontief's (1970) input-output matrix from which the standard accounting tool – an integrated system of capital accounts – was derived. However, new econometric models such as vector autoregression and cointegration models that capture the interactions among economic and financial variables have been developed.

MODEL SPECIFICATION AND ANALYTICAL PROCEDURE

This study adopts cointegration analysis to model sustainable economic development in relation to the different public capital investment components of the Nigerian economy. This will answer the question of whether there is a coordinated and integrated approach to resource development in Nigeria. The appeal of the cointegration analysis is that it provides an effective formal framework for estimating, testing and modeling long-run economic relationships from time-series data.

AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) MODEL APPROACH TO COINTEGRATION

Specifically, the capital components and sustainable economic development relationship in this study are modeled following the *Autoregressive Distributed Lag (ARDL) Model Approach to Cointegration* proposed by Pesaran *et al.* (2001). An ARDL is a least squares regression containing lags of the dependent and explanatory variables. ARDLs are usually denoted with the notation, ARDL(p, $q_1, \dots, q_k$), where p is the number of lags of the dependent variable, $q_1$is the number of lags of the first

explanatory variable, and q_k is the number of lags of the k-th explanatory variable.

The choice of this methodology is based on several considerations. Firstly, as shown by Pesaran et al. (2001), the ARDL models yield consistent estimates of the long run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(1) or I(0). Secondly, this technique generally provides unbiased estimates of the long run model and valid t-statistics even when some of the regressors are endogenous (Harris, 2003). Pesaran (1999) have shown that the inclusion of the dynamics may help correct the endogeneity bias.

To illustrate the ARDL modeling approach, the following simple model is considered:

$y_t = \alpha + \beta x_t + \delta z_t + e_t$

where y_t, x_t and z_t are three different time series; e_t is a vector of stochastic error terms; and *a* and *b* are the parameters. For the above equation, the error correction version of the ARDL model is given by:

$\Delta y = \alpha_0 + \sum_{t=1}^{p} \beta_1 \Delta y_{t-1} + \sum_{t=1}^{p} \delta_1 \Delta x_{t-1} + \sum_{t=1}^{p} \varepsilon_1 \Delta z_{t-1} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1} + u_1$

The first part of the equation above with *b*, *d* and *e* represents the short run dynamics of the model, whereas the second part with λ's represents the long run relationship. The null hypothesis of no cointegration in the long run relationship, defined by Ho: $\lambda_1 = \lambda_2 = \lambda_3 = 0$, is tested against the alternative of Ha: $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq 0$, by means of linear/non-linear F- test or Wald tests of coefficient restriction. For more information on ARDL see Pesaran, M. H and Shin, Y (1999).

In this study, the capital components, using Nigeria's classifications and sustainable economic development measured in terms of Real Gross Domestic Product relationship is stated in regression form as follows:

$$logRGDP_t = \beta_0 + \beta_1 logADMIN_t + \beta_2 logECO_t + \beta_3 logHUSOC_t + \beta_4 logTRANS_t + \epsilon_t \ldots 1$$

Where:

$RGDPg_t$ = Real Gross Domestic Product growth rate at time t

$ADMIN_t = investments\ in\ administration$

$ECO_t = investments\ in\ economic\ services$

$HUSOC_t = investments\ in$ human and social capital

$TRANS_t = transfer\ investments$

ϵ_t = stochastic error term

$\beta_1, \beta_2, \beta_3, \beta_4\ are\ paremeters\ to\ be\ estimated$

.

The apriori expectation of the explanatory variables of these models with respect to the dependent variables are given by their respective parameter estimates as: $\beta_1 > 0$; $\beta_2 > 0$; $\beta_3 > 0$; and $\beta_4 < 0$. This implies that positive relationships are expected between investments in economic services, human and social services as well as investments in general administration and Real Gross Domestic Products, whereas a negative relationship is expected between Transfers investments and the dependent variables.

DATA

Annual data for public sector capital investments and sustainable economic development variable for the period 1985-2015 were sourced from the publications of the Central Bank of Nigeria (CBN) Statistical Bulletin, 2016.

DIAGNOSTIC TESTS

Bounds Tests for the Existence of Cointegration

The first step is to determine if the variables are cointegrated and this is done using Bounds Test of cointegration. The Bounds Test displays the output of the Bounds Test of cointegration, displaying the F-statistic and the 10%, 5%, 2.5% and 1% bounds for both I(0) and I(1) cases

Hypothesis: Ho: No cointegration

Decision criteria:

F-statistic <I(0) accept Ho.

I(0) < F-statistic < I(1) area of indecision.

F-statistic >I(1) reject Ho.

COINTEGRATION AND LONG RUN FORM

If the variables are found to be cointegrated, the Cointegration and Long Run Form test follows.

This displays the cointegration form of the estimated ARDL model, along with the long-run coefficients and error correction representation for the ARDL Model. The error correction *representation for the ARDL Model* result indicates the speed of adjustment back to the long run equilibrium after a short run shock. It is also indicative of any causal effect running from the predictor variables to the dependent variable.

SERIAL CORRELATION AND HETEROSCEDASTICITY

To ascertain the goodness of fit of the ARDL model, further diagnostic tests were conducted. The diagnostic test examined the serial correlation, and heteroscedasticity associated with the model.

FORECAST EVALUATION

The statistics; Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error, Thiel Inequality Coefficient, Bias Proportion, Variance Proportion, and Covariance Proportion are used to check the forecasting ability of the models. The smaller the Root mean squared error, mean absolute error and mean absolute percent error compared to forecasts for the same series across different models, the better the forecasting ability of the model. The Theil inequality coefficient always lies between zero and one, where zero indicates a perfect fit. The bias proportion tells us how far the mean of the forecast is from the mean of the actual series. The variance proportion tells us how far the variation of the forecast is from the variation of the actual series. The covariance proportion measures the remaining unsystematic forecasting errors. The bias, variance, and covariance proportions add up to one. If the forecast is "good", the bias and variance proportions should be small so that most of the bias should be concentrated on the covariance proportions. For additional discussion of forecast evaluation, see Pindyck and Rubinfeld (1998, p. 210-214).

UNIT ROOT TESTS

It is necessary to test for unit root to ensure that all the variables satisfy the underlying assumption of the ARDL methodology before proceeding to the estimation stage. One of such assumptions is that the variables must be either I(0) or I(1) and the dependent variable should be I(1). With this in mind, we start the econometric analysis by analyzing the order of integration of the variables using Augmented Dickey and Fuller Unit Root Tests (ADF).

Finally, to effectively conduct the analyses using the proposed methods of analysis, E-views 10 econometric software - a product of Quantitative Micro Software, LLC was used.

ANALYSIS AND RESULTS

Data Presentation

Yearly data on Log(capital expenditure on Administration), Log(capital expenditure on Economic services), Log(capital expenditure on Social and community services), Log(capital expenditure on Transfer services), and Log(Real GDP) are shown in appendix 1.

Table 1: Augmented Dickey –Fuller Unit Root Test

Variable	Adf-stats	5%	10%	$\sim I(d)$
Log(Administration services)	-10.11825	-2.954021	-2.615817	$I(1)$
Log(Economic services)	-6.135974	-2.954021	-2.615817	$I(1)$
Log(Social services)	-9.220072	-2.954021	-2.615817	$I(1)$
Log(Transfer services)	-3.326650	-2.951125	-2.614300	$I(0)$
		Dependent Variables		
Log(Real GDP)	-3.378729	-2.954021	-2.615817	$I(1)$

Source: e-views and author compilation

The integration properties of the variables are shown in table 1 above. From table 1, the results of the ADF unit root tests indicate that the natural logarithm of capital investments in Administration services, Economic services and Transfer services are stationary at first difference while Log(Transfer services) is integrated at order zero, $(I(0))$. From the Augmented Dickey-Fuller test results which show a combination of $I(0) and\ I(1)$ in the integration properties of the variables with the dependent variables at $I(1)$, the application of ARDL approach to cointegration is justified.

ARDL COINTEGRATION RESULTS OF REAL GDP EQUATION

$$logRGDP_t = \beta_0 + \beta_1 logADMIN_t + \beta_2 logECO_t + \beta_3 logHUSOC_t + \beta_4 logTRANS_t + \epsilon_t \ldots 1$$

The estimated real GDP equation with public sector capital investment variables as predictors covered an adjusted sample period from 1987 – 2015. Out of the 81 models evaluated, ARDL(1, 2, 0, 1, 2) was selected based on Akaike info criterion (AIC) (see figure 4.1 below).

The estimated real GDP equation results (see appendix 2) reveal that public capital investments explain about 99.8% (Adjusted R-squared) of the changes in RGDP. The result also shows that the model has global utility with an F-statistic value, 1395.923 and Probability -F-statistic of zero (0.000000). The study finds that past one period RGDP positively and significantly affects current RGDP. Also, current and one period lag of capital investments in social and community services show positive and significant relationships with RGDP while current capital investments in transfer services and two periods' lag of capital investments in transfer services have negative and significant relationship with RGDP. On the other hand, capital investments in transfer services lagged one period have a positive and significant relationship with RGDP. For capital investments in economic services; the results reveal a negative and significant relationship at 10% level of significance against apriori expectations.

MODEL LAG SELECTION CRITERIA AND SPECIFICATION

The estimated real GDP equation with public sector capital investment variables as predictors covered an adjusted sample period from 1987 – 2015. Out of the 81 models evaluated, ARDL(1, 2, 0, 1, 2) was selected based on Akaike info criterion (AIC) (see figure 1 below).

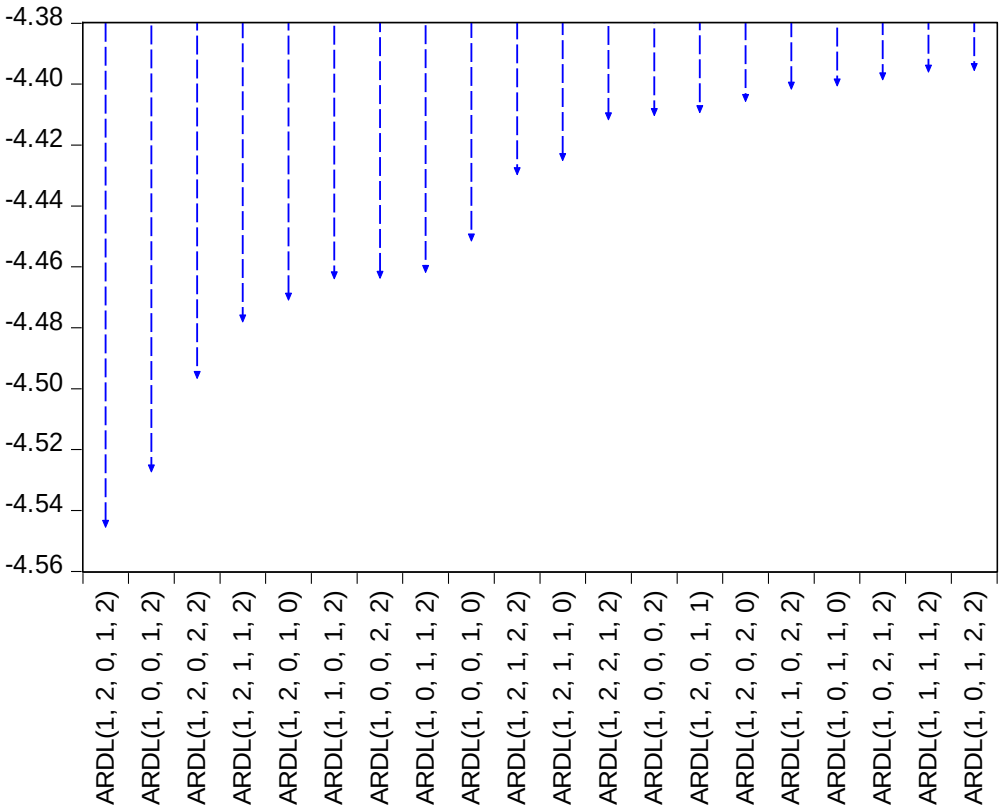


Figure 1: Akaike Information Criteria (top 20 models evaluated)

DIAGNOSTIC TESTS

Table 2: Breusch-Godfrey Serial Correlation LM Test: (full results are in appendix 3)

F-statistic	1.805870	Prob. F(2,16)	0.1963
Obs*R-squared	5.340703	Prob. Chi-Square(2)	0.0692

Table 3: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.672278	Prob. F(10,18)	0.7358
Obs*R-squared	7.885869	Prob. Chi-Square(10)	0.6400
Scaled explained SS	8.500851	Prob. Chi-Square(10)	0.5800

To ascertain the goodness of fit of the estimated ARDL model, serial correlation and heteroscedasticity tests were conducted. The results shown in table 2 and 3 above indicate that the model has a good fit following the F-statistic and Obs*R-squared values and probabilities which reject the null hypotheses that there are serial correlation and heteroscedasticity in the model.

ARDL BOUNDS TEST EMPIRICAL RESULT

Having established the stability of the model, the Bounds test for Cointegration is shown below in table 4.

Table 4: Bounds test for cointegration

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	8.893673	10%	2.45	3.52
K	4	5%	2.86	4.01
		2.5%	3.25	4.49
		1%	3.74	5.06

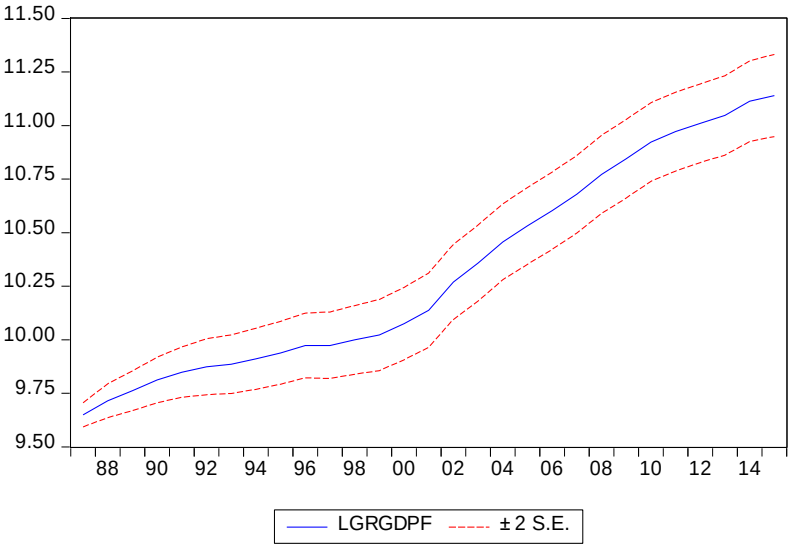
Given the ARDL Bounds Test Decision criteria that if F-statistic < I(0) accept Ho.; If I(0) < F-statistic < I(1) area of indecision; If F-statistic > I(1) reject Ho, the results in table 4 above with an F-statistics value of 8.893673 higher than the 5% critical value I(1) bound of 4.01 show that there is a long run relationship between RGDP and public sector capital investments in administration, economic services, social and community services as well as transfer services.

ERROR CORRECTION MODEL (ECM) RESULT

The fact that the variables in our model are cointegrated provides support for the use of an error correction model (ECM) in order to investigate the short run dynamics. Estimation results, still based on the Akaike Information criterion, are presented in appendix 5.

The error correction coefficient has the expected negative sign and is significant. This helps reinforce the finding of a long run relationship among the variables in the model. The results shown in appendix 3 suggest that the immediate impact of changes in public capital investments is significant at the 5 per cent level. The statistically significant error-correction term confirms the existence of long run relationships between public capital investments and real GDP and emerges as an important channel of influence. Specifically, the results show that public capital investments have causal influence on real GDP in the Nigerian economy through the significant error correction term.

FORECAST EVALUATION



Forecast: LGRGDPF	
Actual: LGRGDP	
Forecast sample: 1985 2015	
Adjusted sample: 1987 2015	
Included observations: 29	
Root Mean Squared Error	0.016777
Mean Absolute Error	0.012218
Mean Abs. Percent Error	0.119570
Theil Inequality Coefficient	0.000812
Bias Proportion	0.008592
Variance Proportion	0.068055
Covariance Proportion	0.923353
Theil U2 Coefficient	0.270523
Symmetric MAPE	0.119585

The result of the forecast evaluation on Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error, Thiel Inequality Coefficient, Bias Proportion, Variance Proportion, and Covariance Proportion show that sustainable economic development measured by real gross domestic product can be predicted using public sector capital investments as can be observed from the values of all the statistics (see figure 2 below). Observe that if the forecast is "good", the bias and variance proportions should be small so that most of the bias should be concentrated on the covariance proportions. From the results, the Bias and Variance proportions are 0.008592 and 0.068055 respectively while the covariance proportion is 0.923353 confirming that the forecast is good.

CONCLUSION

This paper applied the bounds test under the ARDL model approach to cointegration to investigate the relationship between public capital investments and real gross domestic product. Public capital investments was decomposed into capital investments in administration, economic, social and community services as well as transfer services while sustainable economic development was measured by Real Gross Domestic Product. Empirical results show that there is a long run relationship between public capital investments and economic development. Furthermore, the long run form tests through the error correction term indicate that public capital investments have a causal effect on economic development. In addition, the result of the forecast evaluation on Root Mean Squared Error, Mean Absolute Error, Mean Absolute Percent Error, Thiel Inequality Coefficient, Bias Proportion, Variance Proportion, and Covariance Proportion show that economic development can be predicted using public capital investments variables of capital investments in administration, economic, social and community as well as transfer services. The study therefore concludes that public capital investments promote economic development in Nigeria.

The study recommends increasing capital investments in social and community services (education and health) as it has proven to be beneficial to economic development through human capital development. On the other hand, capital

investments in transfer services should be minimized as it negatively affects RGDP. Furthermore, capital investments in economic services should be re-examined to identify possible leakages that negate its effect on real GDP against apriori expectations.

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Appendix 1

Log(capital expenditure on Administration), Log(capital expenditure on Economic services), Log(capital expenditure on Social and community services), Log(capital expenditure on Transfer services), andLog(Real GDP)

	LGRGDP	LGADMIN	LGECO	LGHUSOC	LGTRANS
1985	9.612728	-0.7774	-0.1135	0.143234	1.084649
1986	9.631547	-1.32878	0.095219	-0.42251	1.872832
1987	9.633248	0.596746	0.769969	-0.47949	0.575208
1988	9.693715	0.641117	0.755511	0.545807	0.950422
1989	9.758154	0.96222	1.367698	0.612371	1.89394
1990	9.868152	1.071549	1.248669	0.740031	2.743868
1991	9.862617	1.207467	1.145814	0.399916	3.013533
1992	9.884314	1.632861	0.84874	0.757342	3.40703
1993	9.899881	2.089602	2.909341	1.274049	3.198677
1994	9.902443	2.173057	3.299637	1.608317	3.402397
1995	9.920993	2.590602	3.764664	2.220898	4.015224
1996	9.960714	2.698915	4.769235	2.158276	4.270779
1997	9.989165	3.902962	5.13352	1.931811	3.774773
1998	10.01381	3.563044	5.302618	3.151265	3.90233
1999	10.01902	3.75507	5.779449	2.848015	4.740191
2000	10.07274	3.975552	4.714102	3.330961	3.843693
2001	10.13728	3.897009	5.55975	3.976612	4.335299
2002	10.27359	4.298338	5.372188	3.480233	-9.21034
2003	10.36437	4.47687	4.584785	4.020626	-4.48295
2004	10.46369	4.925556	5.122307	3.402281	2.755559
2005	10.53143	5.145015	5.579861	4.267754	2.442347
2006	10.59652	5.221567	5.569135	4.365406	3.268539
2007	10.66715	5.424837	5.881582	5.016585	3.137058
2008	10.73667	5.659843	6.223145	5.025029	2.852151
2009	10.8169	5.675589	6.226556	4.976227	5.348059
2010	10.90801	5.561451	6.021509	5.022396	4.089332
2011	10.95973	5.445875	5.956873	4.530973	5.335131
2012	11.00093	5.249652	5.77113	4.578826	5.58312
2013	11.05436	5.647739	6.226072	5.041531	5.101483
2014	11.11473	5.436479	5.974941	4.712139	3.88675
2015	11.14221	5.424094	5.854346	4.41856	5.074067

SOURCE: author computation

Appendix 2

Dependent Variable: LGRGDP
Method: ARDL
Date: 05/04/18 Time: 08:16
Sample (adjusted): 1987 2015
Included observations: 29 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LGADMIN LGECO LGHUSOC
LGTRANS
Fixed regressors: C
Number of models evalulated: 81
Selected Model: ARDL(1, 2, 0, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LGRGDP(-1)	0.950361	0.032454	29.28360	0.0000
LGADMIN	-0.006570	0.018915	-0.347374	0.7323
LGADMIN(-1)	0.011058	0.014658	0.754398	0.4604
LGADMIN(-2)	-0.026275	0.015364	-1.710154	0.1044
LGECO	-0.018222	0.010071	-1.809431	0.0871
LGHUSOC	0.022423	0.014803	1.514758	0.1472
LGHUSOC(-1)	0.043027	0.016384	2.626249	0.0171
LGTRANS	-0.004284	0.001872	-2.288101	0.0344
LGTRANS(-1)	0.001821	0.001850	0.984134	0.3381
LGTRANS(-2)	-0.003561	0.001759	-2.024577	0.0580
C	0.539688	0.310353	1.738951	0.0991

R-squared	0.998712	Mean dependent var	10.31885
Adjusted R-squared	0.997997	S.D. dependent var	0.484130
S.E. of regression	0.021669	Akaike info criterion	-4.544210
Sum squared resid	0.008451	Schwarz criterion	-4.025581
Log likelihood	76.89105	Hannan-Quinn criter.	-4.381782
F-statistic	1395.923	Durbin-Watson stat	2.177258
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 3

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.805870	Prob. F(2,16)	0.1963
Obs*R-squared	5.340703	Prob. Chi-Square(2)	0.0692

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 05/04/18 Time: 10:05
Sample: 1987 2015
Included observations: 29
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGRGDP(-1)	0.002467	0.032323	0.076329	0.9401
LGADMIN	0.000546	0.019089	0.028611	0.9775
LGADMIN(-1)	0.009216	0.015108	0.609968	0.5504
LGADMIN(-2)	0.011527	0.015921	0.724001	0.4795
LGECO	-0.004095	0.010450	-0.391859	0.7003
LGHUSOC	-0.013008	0.015967	-0.814683	0.4272
LGHUSOC(-1)	-0.007948	0.016245	-0.489266	0.6313
LGTRANS	-0.000571	0.001857	-0.307624	0.7623
LGTRANS(-1)	-0.000189	0.001778	-0.106411	0.9166
LGTRANS(-2)	0.000478	0.001719	0.278322	0.7843
C	-0.016352	0.308546	-0.052996	0.9584
RESID(-1)	-0.240575	0.262325	-0.917088	0.3727
RESID(-2)	-0.526205	0.287819	-1.828250	0.0862

R-squared	0.184162	Mean dependent var	3.02E-15
Adjusted R-squared	-0.427716	S.D. dependent var	0.017374
S.E. of regression	0.020759	Akaike info criterion	-4.609819
Sum squared resid	0.006895	Schwarz criterion	-3.996893
Log likelihood	79.84238	Hannan-Quinn criter.	-4.417858
F-statistic	0.300978	Durbin-Watson stat	2.106856
Prob(F-statistic)	0.979560		

Appendix 3a

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.672278	Prob. F(10,18)	0.7358
Obs*R-squared	7.885869	Prob. Chi-Square(10)	0.6400
Scaled explained SS	8.500851	Prob. Chi-Square(10)	0.5800

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/04/18 Time: 20:56
Sample: 1987 2015
Included observations: 29

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.006667	0.010694	0.623421	0.5408
LGRGDP(-1)	-0.000554	0.001118	-0.495417	0.6263
LGADMIN	-0.000335	0.000652	-0.514550	0.6131
LGADMIN(-1)	0.000188	0.000505	0.371982	0.7142
LGADMIN(-2)	0.000149	0.000529	0.281667	0.7814
LGECO	-0.000271	0.000347	-0.780580	0.4452
LGHUSOC	-0.000254	0.000510	-0.498066	0.6245
LGHUSOC(-1)	0.000444	0.000565	0.786849	0.4416
LGTRANS	2.71E-05	6.45E-05	0.419830	0.6796
LGTRANS(-1)	1.87E-05	6.38E-05	0.292821	0.7730
LGTRANS(-2)	-8.22E-06	6.06E-05	-0.135598	0.8936

R-squared	0.271927	Mean dependent var	0.000291
Adjusted R-squared	-0.132559	S.D. dependent var	0.000702
S.E. of regression	0.000747	Akaike info criterion	-11.28018
Sum squared resid	1.00E-05	Schwarz criterion	-10.76155
Log likelihood	174.5626	Hannan-Quinn criter.	-11.11775
F-statistic	0.672278	Durbin-Watson stat	2.114437
Prob(F-statistic)	0.735791		

Appendix 4

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LGRGDP)
Selected Model: ARDL(1, 2, 0, 1, 2)
Case 3: Unrestricted Constant and No Trend
Date: 05/04/18 Time: 08:20
Sample: 1985 2015
Included observations: 29

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.539688	0.310353	1.738951	0.0991
LGRGDP(-1)*	-0.049639	0.032454	-1.529520	0.1435
LGADMIN(-1)	-0.021788	0.021035	-1.035766	0.3140
LGECO**	-0.018222	0.010071	-1.809431	0.0871
LGHUSOC(-1)	0.065451	0.020423	3.204684	0.0049
LGTRANS(-1)	-0.006024	0.002819	-2.136654	0.0466
D(LGADMIN)	-0.006570	0.018915	-0.347374	0.7323
D(LGADMIN(-1))	0.026275	0.015364	1.710154	0.1044
D(LGHUSOC)	0.022423	0.014803	1.514758	0.1472
D(LGTRANS)	-0.004284	0.001872	-2.288101	0.0344
D(LGTRANS(-1))	0.003561	0.001759	2.024577	0.0580

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGADMIN	-0.438923	0.603463	-0.727339	0.4764
LGECO	-0.367096	0.169578	-2.164760	0.0441
LGHUSOC	1.318542	0.839255	1.571086	0.1336
LGTRANS	-0.121361	0.122935	-0.987196	0.3366

EC = LGRGDP - (-0.4389*LGADMIN -0.3671*LGECO + 1.3185*LGHUSOC
-0.1214*LGTRANS)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic:		

			n=1000	
F-statistic	8.893673	10%	2.45	3.52
K	4	5%	2.86	4.01
		2.5%	3.25	4.49
		1%	3.74	5.06
			Finite Sample:	
Actual Sample Size	29		n=35	
		10%	2.696	3.898
		5%	3.276	4.63
		1%	4.59	6.368
			Finite Sample:	
			n=30	
		10%	2.752	3.994
		5%	3.354	4.774
		1%	4.768	6.67

t-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-1.529520	10%	-2.57	-3.66
		5%	-2.86	-3.99
		2.5%	-3.13	-4.26
		1%	-3.43	-4.6

Appendix 5

ARDL Error Correction Regression
Dependent Variable: D(LGRGDP)
Selected Model: ARDL(1, 2, 0, 1, 2)
Case 3: Unrestricted Constant and No Trend
Date: 05/04/18 Time: 08:25
Sample: 1985 2015
Included observations: 29

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.539688	0.065650	8.220651	0.0000
D(LGADMIN)	-0.006570	0.009413	-0.698022	0.4941

D(LGADMIN(-1))	0.026275	0.011082	2.371096	0.0291
D(LGHUSOC)	0.022423	0.011203	2.001472	0.0606
D(LGTRANS)	-0.004284	0.001227	-3.491467	0.0026
D(LGTRANS(-1))	0.003561	0.001333	2.671466	0.0156
CointEq(-1)*	-0.049639	0.006733	-7.372260	0.0000

R-squared	0.752042	Mean dependent var	0.052092
Adjusted R-squared	0.684416	S.D. dependent var	0.034890
S.E. of regression	0.019600	Akaike info criterion	-4.820072
Sum squared resid	0.008451	Schwarz criterion	-4.490036
Log likelihood	76.89105	Hannan-Quinn criter.	-4.716709
F-statistic	11.12076	Durbin-Watson stat	2.177258
Prob(F-statistic)	0.000010		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.893673	10%	2.45	3.52
K	4	5%	2.86	4.01
		2.5%	3.25	4.49
		1%	3.74	5.06

t-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-7.372260	10%	-2.57	-3.66
		5%	-2.86	-3.99
		2.5%	-3.13	-4.26
		1%	-3.43	-4.6