THE SOURCES OF LONG-RUN ECONOMIC GROWTH IN NIGERIA, 1961-2013: A Growth Accounting Exercise.

Iyaji Danjuma[1] and Iseghohi Judith Omon [2]

[1]Economics Programme, Department of Social Sciences, College of Management and Social Sciences, Salem University, Lokoja. Email: danjumaiyaji@gmail.com, Mobile: 234-0806-4373-210

[2]Department of Economics & Statistics, Faculty of Social Sciences, University of Benin, Benin City.

Email: judithiseghohi@yahoo.com Mobile: +234-0802-3531-448

Abstract

This study examines the sources of long-run economic growth in Nigeria, 1961-2013 a growth accounting exercise. The study adopted co-integrated and Error- Correction Modeling using Autoregressive Distributed Lag (ARDL). The empirical results review that one period lag of real gross domestic product, acts as the major determinant of long-run economic growth in Nigeria. The coefficient of determination is 59% which is an indication that stock of capital and labor force impact on the long-run economic growth but cannot generate intensive productivity based growth for Nigeria. Total factor productivity remains the source of growth most closely identified with technological gains. Furthermore, the study discovered that, Nigeria has experienced divergent oscillatory growth tragedy due to applicability of extensive growth process. It is therefore, recommended that the Nigerian government should focus more on intensive productivity based growth process this requires commitment to investment in education and the stakeholders in education as a matter of urgency should also be committed to production of quality human capital that are creative, innovative and inventive. This is the core of technological advancement which represents Solow's residual and this residual is originally taken as the contribution of technical change or technological progress. It has since become known as total factor productivity (TFP) since it encompasses all sources of economic growth apart from those attributable to capital and labor.

Keywords: Growth, Accounting, Labor force, Capital stock, Total Factor Productivity (TFP), Intensive and Extensive Growth.

1.0 Introduction

A nation's ability to provide improving standards of living for its people depends crucially on its long-run rate of economic growth. Over a long period of time, even an apparently small difference in the rate of economic growth can translate into a large difference in the income of the average person.

No one understands completely why economies grow, and no one has a magic formula for inducing rapid growth. Indeed, if such a formula existed, there would be no poor nations. Nevertheless, economists have gained useful insights about the growth process. This research identifies the forces that determine the growth rate of an economy over long periods of time and examine various policies that governments may use to try to influence the rate of growth. Saving

and investment decisions play a central role in the analysis. Alongside with changes in productivity, the rates at which a nation saves and invests—and thus the rate at which it accumulates capital goods—are important factors in determining the standard of living that citizen can attain.
Economic growth implies increases in per-capita real gross domestic product (GDP), namely widening of the production scale in a country as a whole, or more efficient use of its economic resources to produce goods and services. Although development per se encompasses a wide range of phenomena ranging from indicators of "quality of life" to "human development," the increase in per-capita GDP is a major component of economic and social development such as reduction of poverty, income inequality and unemployment. Since the scale of production or productivity can only be increased in the long-run, secular economic growth is considered a long-run phenomenon.

In order to successfully map out a strategy for accelerating Nigeria's economic growth rate under this democratic dispensation, it is necessary to fully understand the sources of long-run economic growth in Nigeria during the past five decades. A widely accepted framework for doing this is growth accounting. Solow (1957) was the pioneer on the growth accounting frame. The practical applicability of this framework on the Nigerian economy was pioneered by Dike, (1995) and Iyoha, (2000). Dike used investment in place of capital stock, while Iyoha on the contrary used capital stock data in estimating total factor productivity as required by the theory, which is an improved and more sophisticated methodology and his results obtained were more realistic and appealing as well as quite robust because of the use of capital stock instead of investment as used by Dike.

Basically, growth accounting provides a breakdown of observed economic growth into its main components such as, the changes attributable to the growth in factor inputs (usually Capital and Labor) and the residual or unexplained component. This last component, often called Solow's residual was originally taken as the contribution of technical change or technological progress. It has since become known as total factor productivity (TFP) since it encompasses all sources of economic growth apart from those attributable to capital and labor (Iyoha, 2000).

Why does the source of growth matter? The neoclassical growth model, with its main assumption of diminishing returns in physical capital provides the answer. If this assumption is correct and the large empirical growth literature tends to support it- capital accumulation cannot sustain long-run growth while total factor productivity can. Therefore, the sources of growth is crucial for the long-run perspective of a country like Nigeria.

Long-run economic growth is the central concern to policymakers as the extent of quality of life improvements in future years depends on the ability of the economy to grow sustainably in the long-run. More precisely, quality of life improvements depend on the ability of the economy to produce and diffuse new innovations and to find ways to use capital and labor more efficiently. Economic growth comes from the accumulation of labor and capital inputs combined with improvements in the productivity of labor and capital inputs arising from on-going scientific progress, technological change, innovation scale economies and efficiency of factor use (Thomas, 2015).

Orthodox economics described two types of economic growth: extensive growth and intensive growth. Extensive growth is obtained by adding more units of labor or capital, or both, whereas intensive growth is obtained by increasing the average productivity of labor or capital, or both. Diminishing returns to capital and labor make it impossible to sustain economic growth in the absence of productivity improvements. The traditional neoclassical growth models describe how the per capita level of output will be static in the long-run unless the productivity of capital and labor grows over time (Solow, 1956). The implication is that long-run increases in per capita output can only be achieved through intensive productivity based growth.

Total factor productivity remains the source of growth most closely identified with technological gains. According to Romer, (1990) 'influencing the cost of finding and using new ideas' is the key to economic growth, while Mokyr, (2002) argues that 'in many respects the stories of economic growth and human history are the stories of technological change and changing beliefs and ideas'.

It is now common to view the growth accounting exercise as a preliminary step for the examination of the fundamental determinants of economic growth in any economy. Often, the final step in growth accounting study is to relate factor growth rates, relative factors shares and total factor productivity (TFP) to such elements as government policies (particularly economic reform), openness, natural resources, and initial levels of physical and human capital. Results from the growth accounting exercise permit a determination of whether growth is "extensive" or "intensive", i.e. whether economic growth has been propelled by factor input growth or driven largely by productivity increases (Iyoha, 2000).

The reason for the distinction is to determine if observed economic growth in such an economy is "sustainable". If the growth is mainly propelled by rapid increases in capital stock, such growth may not be sustainable in the long-run. However, if the growth is driven by increases in total factor productivity, such growth could be sustained almost indefinitely. As such results obtained from a growth accounting study like this can be used to project the future growth rates of real GDP and real GDP per capita in Nigeria

Nigeria government has not been able to create conducive working environment for the educated Nigerians who will have used their knowledge in building the strong technological base for a sustainable economic growth for this country; as such her prior investments in the education and knowledge capacity of the workforce has been drained by developed economies. Clinton, (2003) said "if all Nigerian Doctors leave United States of America, American health system will collapse". It is an indication that Nigerian government does not have policy framework and infrastructural facilities to retain the trained workforce.

Most Nigerians who traveled overseas on scholarship under various scholarship studies are attempted to stay back in their host country of study and even those who enjoyed one form of educational subsidies within Nigerian Universities take to their heels as soon as opportunities of migration present itself to them because Nigerian government invest heavily in education but the infrastructure that attract and retain this people are not put in place due to "high-level, grand, or political" corruption and "petty, administrative, or bureaucratic" corruption. This has led to divergent oscillatory growth tragedy the country has faced over these five decades.

This paper argues that the best way to sustain growth in productivity over the long-term in Nigeria is to invest in technological advancement in all sectors of economics.

1. Related Literature Review

As demonstrated empirically by a number of recent papers as reviewed below, economic growth plays a critical role in lowering poverty. This paper investigates the Solow's residual, by examining the sources of long-run economic growth in Nigeria using growth accounting framework and drawing lessons for growth prospects from literatures reviewed below.

Abramovitz (1956) and Robert Solow (1957) used growth accounting methods to separately estimate that 85% to 90% of economic growth in the US economy over the previous century could not be explained by the increases in the capital stock and the labor force over that period. The unexplained residual within their models is now commonly called Total Factor Productivity (TFP). Much of the residual was assumed to be the result of productivity enhancing technological change. As Krugman, (1997) put it, 'Productivity isn't everything, but in the long-run it is almost everything.

Bosworth and Collins (2003) argued that the growth accounting framework is a useful tool to understand growth experiences across countries. The same authors have, however, noted the limitations of this methodology. A key weakness relates to the interpretation that the measured residual from the growth accounting exercise represents TFP growth. In practice, in addition to providing a measure of gains in economic efficiency, the residual may also reflect a number of other factors, including political disturbances and conflicts, institutional changes, droughts, external shocks, changes in government policies, and measurement errors. This limitation is particularly important for sub-Saharan African countries mired in conflicts and subject to significant drought-related and external shocks. Also, the results from growth accounting exercise should not be misconstrued as providing the fundamental causes of growth (rather than the proximate sources of growth).

Whitt (2009) argues that 'in a globally evolving marketplace, new ideas and technologies are the fodder for economic growth,' and indeed the proximate cause of the large TFP gaps that opened up between countries in the 19th century was due to new industrial technologies being implemented in some countries but not in others (Crafts & O'Rourke, 2013). Yet TFP growth and technological progress are not the same. Scale economies and improvements in the efficiency of use of capital and labor also contribute to TFP growth. Changes in TFP arise not just from changes in technology but also from changing policies and institutions (Easterly & Levine, 2001). Social norms and institutions are important as enabling or limiting factors in the growth process.

Institutions are the structures. That human impose on themselves to order their environment. Such institutional norms condition economic incentives, expectations and behavior (North, 1990). Examples of institutions include, but are not limited to, the quality of governance, the regulatory system, the education system, the strength and predictability of property rights, the workings of the financial system, the pervasiveness of corruption, the level of political stability, trade policy, fiscal policy including the design of the tax system, the legal system including the existence of patent law and anti-trust legislation, as well as social and cultural norms including generalized levels of trust. Generalized institutions or those of more universal application i.e. more closely resembling a level playing field – are conducive to growth. However, institution's whose application varies sharply by group membership hinders growth (Ogilvie & Carus, 2014).

Yet, crucially, growth depends not only on the ability to import technologies from leading economies, but also on whether those technologies are actually applied as part of the production process (Abramovitz, 1986). TFP can differ across countries for technology reasons or for efficiency reasons and a workable model of long-run productivity growth must contain at least two driving forces, namely the dynamic processes of technological change and institutional changes.

Productive and allocative efficiencies may be, if not more, important than technology differences. A study by Jerzmanowski (2006) estimates 47% of cross country variation in output per worker was attributable to TFP in 1995. However, just 21% of the variation actually came from technology differences while 22% of variation came from differences in efficiency of use. The remaining 10% of cross-country variation was attributable to differences in factor inputs (capital and labor) Hsieh, and Klenow, (2007) suggest that inefficiency reasons for TFP gaps between countries might relate to institutional structures and resource misallocation. Institutions can be impediments to technological change to the extent that strong vested interest groups are able to prevent or delay change. The institutional structures that impinge on technological change are part of the system of innovation (Edquist, 2005).

2.1 Learning and Increasing Returns to Scale

Most modern theories of long-run economic growth emphasize the centrality of technological change (Thomas, 2013). In turn, the cost of knowledge production and diffusion is seen as the main determinant of the rate of technological change. Knowledge is neither freely available nor omnipresent and Rosenberg (1972) argues that every innovation or incremental advance in the stock of knowledge has its own cost of production.

The incentive for engaging in knowledge generating activities will increase if the cost of producing or acquiring an innovation falls without a commensurate decline in the benefits of the innovation. The rate of innovation depends not just on the market and market players but also on the institutional constraints. This is because the prevailing set of institutions will influence the costs and benefits of engaging in knowledge production and in other innovative activities.

Arrow, (1991) points out that, although the cost of acquiring knowledge is independent of the scale on which the knowledge is eventually used, the benefit obtained from the knowledge will very much depend on the scale at which it is eventually used. The inexhaustibility (non-depletion) of knowledge generates increasing returns to scale, which in turn generates productivity improvements. It is these productivity gains that counteract the effect of diminishing marginal returns to capital and labor and allow economies to grow in the long-run.

The United States (US) has been the technological frontier economy since at least the outbreak of the First World War; Per capita growth in the frontier economy is largely determined by the pushing back of the technological frontier and the diffusion and use of new technologies (products and processes) through the economy. Nicholas Crafts and Kevin O'Rourke (2013) describe how investments in human capital (education) and in Research and Development increased substantially in the US during the 20th century and were much higher in absolute terms than in other countries. The US had the highest average rates of educational attainment for much of the century. Per capita growth in the US averaged a little over 2% per annum between 1913 and 2013.

It is for this reason that Romer (1990) argues that the key to influencing economic growth is to first influence the cost of obtaining knowledge and generating and spreading new ideas.

2.2 Endogenous Growth Models

The new growth models treat technological change as endogenous (Romer, 1986, 1987, 1990; Lucas, 1988). Their central proposition is that capital accumulation when taken in its broadest sense to include human capital does not exhibit diminishing returns (Mankiw, Romer & Weil, 1992). The growth process is seen as driven by the purposive accumulation of human and physical capital together with the production of new knowledge, often created through Research and Development ctivities, and the subsequent diffusion of that knowledge (Snowdon & Vane, 2005).

According to these models the public benefits to R&D activity will exceed the private benefits because knowledge is only partially excludable. Jones, and Williams (1998) find that the social (i.e. economy wide) rate of return to R&D is between two and four times the private rate of return to R&D. The inability of knowledge producers to internalize all of the benefits of investing in R&D reduces their incentive to undertake such activity in the first place. In addition, although knowledge has a once off payment, the size of the payment is of unknown cost beforehand. This makes knowledge production inherently risky and acts as a further disincentive to knowledge production. The implication is that, when left to its own devices, the market will produce less than the socially optimal amount of new knowledge. The resulting market failure is the standard rationale advanced in favor of activist technology policy, whether in the form of R&D subsidies and tax incentives for the private sector or in the form of direct government investments in R&D and human capital.

3. The Methodology

This study adopted the standard primal model of economic growth accounting as used by (Iyoha, 2000). A “primal” model uses changes in quantities of factors of production while a “dual” model uses changes in factor prices. It seems apparent that for a country like Nigeria where data on prices are not available or unreliable when available, the primal model is to be preferred. The model is standard in that, it uses a neoclassical production function.

$$Y=f(A,K,L)= AK^{\alpha}L^{1-\alpha} \qquad 3.1$$

Where Y is output, K (capital) and L (labor) are the factor inputs and A is Total Factor Productivity (TFP) or the Solow’s residual.

TFP represents the productivity of capital and labor and reflects things like the state of technology and its diffusion, the human capital of the workforce, the strength of economic and political institutions, the sectoral composition of output, and the efficient of use of both capital and labor.

Equation (3.1) relates total output, *Y*, to the economy’s use of capital, *K*, and labor, *L*, and to productivity, *A*. If inputs and productivity are constant, the production function states that output also will be constant—there will be no economic growth. For the quantity of output to grow, either the quantity of inputs must grow or productivity must improve, or both. The relationship between the rate of output growth and the rates of input growth and productivity growth refer to as growth accounting equation. Taking natural logarithm of the production function of Eq. 3.1, and differentiating with respect to time, gives:

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha K \frac{\Delta K}{2K} + (1-\alpha) L \frac{\Delta L}{L} \qquad 3.2$$

Where

$\frac{\Delta Y}{Y}$ = rate of output growth;
$\frac{\Delta A}{A}$ = rate of productivity growth;
$\frac{\Delta K}{K}$ = rate of capital growth;
$\frac{\Delta L}{L}$ = rate of labor growth;
α_K = elasticity of output with respect to capital;
$(1-\alpha)_L$ = elasticity of output with respect to labor.

In Eq. (3.2) the elasticity of output with respect to capital, α_K, is the percentage increase in output resulting from a 1% increase in the capital stock, and the elasticity of output with respect to labor, $(1-\alpha)_L$ is the percentage increase in output resulting from a 1% increase in the amount of labor used. The elasticities α_K and $(1-\alpha)_L$ both are numbers between 0 and 1 that be estimated from historical data.

Equation (3.2), called the growth accounting equation, is the production function (Eq. 3.1) written in growth rate form. Some examples will be helpful for understanding the growth accounting equation.

Suppose that a new invention allows firms to produce 10% more output for the same amount of capital and labor. In terms of the production function, Eq. (3.1), for constant capital and labor inputs, a 10% increase in productivity, *A*, raises output, *Y*, by 10%. Similarly, from the growth accounting equation, Eq. (3.2),if productivity growth, $\Delta A/A$, equals 10% and capital and labor growth are zero, output growth, $\Delta Y/Y$, will be 10%. Thus the production function and the growth accounting equation give the same result, as they should. Now suppose that firms' investments cause the economy's capital stock to rise by 10% ($\Delta K/K$ = 10%) while labor input and productivity remain unchanged. What will happen to output? The production function shows that, if the capital stock grows, output will increase. However, because of the diminishing marginal productivity of capital the extra capital will be less productive than that used previously, so the increase in output will be less than 10%. Diminishing marginal productivity of capital is the reason that the growth rate of capital, $\Delta K/K$, is multiplied by a factor less than 1 in the growth accounting equation.

3.1 Growth Accounting Formula

According to Eq. (3.2), output growth, $\Delta Y/Y$, can be broken into three parts:

1. That resulting from productivity growth, $\Delta A/A$,
2. That resulting from increased capital inputs, $\alpha_K \Delta K/K$, and
3. That resulting from increased labor inputs, $(1-\alpha)_L \Delta L/L$.

Growth accounting measures empirically the relative importance of these three sources of output growth. A typical growth accounting analysis involves the following four steps:

Step 1. Obtain measures of the growth rates of output, $\Delta Y/Y$, capital, $\Delta K/K$, and labor, $\Delta L/L$, for the economy over any period of time. In the calculation of growth rates for capital and labor, more sophisticated analyses make adjustments for changing quality as well as quantity of inputs. For example, to obtain a quality adjusted measure of *L*, an hour of work by a skilled worker is counted as more labor than an hour of work by an unskilled worker. Similarly, to obtain a quality adjusted measure of *K*, a machine that can turn fifty bolts per minute is treated as being more capital than a machine that can turn only thirty bolts per minute.

Step 2. Estimate values for the elasticities α_K and $(1-\alpha)_L$ from historical data for USA. Keep in mind the estimates for the United States of 0.3 for α_K and 0.7 for $(1-\alpha)_L$

Step 3. Calculate the contribution of capital to economic growth as $\alpha_K \Delta K/K$ and the contribution of labor to economic growth as $(1-\alpha)_L \Delta L/L$.

Step 4. The part of economic growth assignable to neither capital growth nor labor growth is attributed to improvements in total factor productivity, *A*. The rate of productivity change, $\Delta A/A$, is calculated from the formula.

3.2 Method of Data Analysis

The study, as many others, obtains TFP estimates with the use of econometric estimation procedures. Econometric estimation procedures is employed to examine if the average estimate of the share of physical capital and human capital are significantly different from usual values (ranging from 0.3 to 0.4) used in growth accounting exercises. It is a complete departure from the work of Senhadji (1999) who estimated the production function parameters in levels and first difference. We now do this straightaway with the aid of cointegration and error correction mechanism (ECM) without loss of generality.

3.3 Model Specification

The production function parameters are central to the decomposition of output growth into contribution from physical capital, labor and productivity. Error Correction Model (ECM) provides the estimates of these parameters for the following production function.

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \qquad 3.3$$

Where Y_t is Real GDP, A_t is TFP, K_t is the stock of capital, L_t is the labor force (economically active population). Taking the logs and differentiating totally both sides of equation 3.3 yields:

$$\acute{y}_t = \grave{a}_t + \alpha \acute{k}_t + (1-\alpha)\acute{l}_t + \delta \acute{u}_{t-1} \qquad 3.4$$

Where the lowercase variables with a "dot" correspond to: $\acute{y}_t$ is the continuous time rate of growth of output, $\acute{k}_t$ is the rate of growth of capital stock, $\acute{l}_t$ is the rate of growth of labor force and $\grave{a}_t$ is the Hicks-neutral rate of change of technological progress. Equation 3.4 in a nutshell decomposes the growth rate of output into the growth of TFP, a weighted average of the growth rates of capital stock and labor force. Under constant returns to scale (assumed here), these weights are given by shares of these two inputs in aggregate output. Since the variables assumed to be cointegrated, before using them for regression we add error correction term which is simply the lagged residual.

Traditionally, equation 3.4 is estimated in first differencing of logs i.e. equation 3.4. Many time-series variables are stationary only after first or second differencing. Using differenced variables for regression would imply the loss of valuable information about the long-run equilibrium relationships between or amongst the variables.

In process of first differencing, valuable information about the long-run behavior or equilibrium of the variables selected for this research; which is the core component of this analysis is inevitably lost. But cointegration literature provided an important insight that, despite being individually nonstationary, a linear combination of two or more time-series can be stationary.

How can the researcher use nonstationary time-series to describe equilibrium or long-run behavioral relationship without producing "nonsense" or "spurious" results? The answer lies in cointegration, which combines short-run dynamics with long-run equilibrium relationship and it is accomplished by utilizing an Error Correction Mechanism (ECM), which basically adds a term containing the lagged residual from the levels regression equation to the specification in first differences. Using ECM symbology, equation 3.4 may be written as:

$$\acute{y}_t = \grave{a}_t + \alpha \acute{k}_t + (1-\alpha)\acute{l}_t + \delta ECM \qquad 3.5$$

The sign should be negative if it is to play the role of error correction. Unit root test will be carried out with the aid of Augmented Dickey-Fuller (ADF). In sum, the presence of a unit root implies that the time-series under scrutiny is nonstationary otherwise the stochastic process is stationary.

3.4 Sources of Data

The data were obtained from the series obtained from the IMF World Economic Outlook (WEO) and the World Bank World Development Indicators databases. The time coverage is 1961-2013

Output is measured by Real GDP expressed in naira value. The labor force is proxied by data on the economically active population. The World Bank database also contained data on investment but not for capital stock. It was therefore, necessary to constructed capital stock data from the investment series using the perpetual inventory method. It is assumed that the initial capital output ratio in 1960 was 3 and the depreciation rate was set at 10 percent. In line with the literature on production function estimates for developing countries, the share of capital (α) is set at 0.4; the findings are robust to an alternative value of α of 0.3.

Data for relative factor shares are not available for Nigeria. Since national income statistics are not totally reliable, the relative share of capital in output could not be obtained from national income data. We therefore, employed capital stock and active labor population to obtain their contribution to growth.

Data Presentation and Analysis

Since the study uses economic time-series data, it is advisable to begin by verifying the time series properties of the variables employed. That is, it is necessary to find out if the variables are stationary or non-stationary. In a nutshell, it is necessary to determine the order of integration of all the variables involved. This is best accomplished by carrying out unit root tests of the variables.

4.1 Unit Root Test

In order to test for the stationarity of variables used in this study, unit root testing of all the selected variables for the model was carried out using Augmented Dickey-Fuller (ADF) methodology. It is considered as the most reliable test of stationarity for economic time-series variables. It is carried out using the MACROFIT4.0 econometric software. The following results were obtained as shown in the table below.

Table 1: Summary of Unit root tests using the ADF Criterion

Variable Decision	Order	ADF	Decision
DLRGDP	1st difference	-21.6600	I(1)
DLKS	1rd difference	-4.2173	I(1)
DLPOP	1st difference	-13.7896	I(1)

Note: 95% critical value for the Dickey Fuller statistics = -3.4469

Note that all the variables employed in the model viz.,: real gross domestic product, stock of capital, and labor force (economically active population) are stationary at first level i.e. I(1) . Given these results, the autoregressive distributed lag model can be used for the econometric estimation of the impact of the equation provided the variables in each equation are co-integrated. Hereunder, are the results of the tests of co-integration obtained by using the ADF technique to test the stationary of the residuals from the OLS regression of the model

4.2 Co-integration Test and ECM using ARDL

When a given set of variables are co-integrated there exists a meaningful long-run relationship among them and the ‘Granger Representation Theorem’ assures us that the short-run dynamics can then be aptly described by error-correction model. The standard method of obtaining this is by using Autoregressive distributed lag (ARDL) model. However, it has been shown that the ARDL model can still be used even when co-integration has not been established. Utilizing the MROFIT 4.0 econometric software, and using the maximum R-bar squared criterion, the study obtained the parsimonious error-correction representation of the model.

It can be verified from the table below that real gross domestic product, stock of capital and labor force (economically active population) are co-integrated, using the residuals units root test. Note that the absolute value of the ADF test (20.1159) is larger than the absolute value of the 95% critical value of the Dickey-Fuller test (3.8179). Thus, there exists a long-run equilibrium relationship among variables.

Table: 2 Co-integration Test results using data for 1961 through 2013

Variable	ADF Statistics	95% ADF Criterion Value	Remarks
Residuals	-20.1159	-3.8179	Stationary

Therefore, we can estimate an Error Correction Model using the autoregressive distributed lag technique. The parsimonious representation of the Error-Correction Model is presented below:

Error Correction Representation for the Selected ARDL Model
ARDL(2,2,0) selected based on R-BAR Squared Criterion
****
Dependent variable is dDLRGDP
113 observations used for estimation from 1911Q4 to 2013Q4
****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
dDLRGDP1	.77087	.065445	11.7788[.000]
dDLKS	.68245	.65069	1.0488[.297]
dDLKS1	.57970	.52542	1.1033[.272]
dDLPOP	-6.2796	5.9286	-1.0592[.292]
dINPT	.067385	.043140	1.5620[.121]
ecm(-1)	-1.8625	.094504	-19.7079[.000]

****
List of additional temporary variables created:
dDLRGDP = DLRGDP-DLRGDP(-1)
dDLRGDP1 = DLRGDP(-1)-DLRGDP(-2)
dDLKS = DLKS-DLKS(-1)
dDLKS1 = DLKS(-1)-DLKS(-2)
dDLPOP = DLPOP-DLPOP(-1)
dINPT = INPT-INPT(-1)
ecm = DLRGDP + .021764*DLKS + 3.3716*DLPOP -.036180*INPT
****

R-Squared	.59314	R-Bar-Squared	.58143
S.E. of Regression	.052895	F-stat. F(5, 107)	81.2853[.000]
Mean of Dependent Variable	.8512E-3	S.D. of Dependent Variable	.11314
Residual Sum of Squares	.29657	Equation Log-likelihood	175.4312
Akaike Info. Criterion	168.4312	Schwarz Bayesian Criterion	158.8854
DW-statistic	2.2450		

****

R-Squared and R-Bar-Squared measures refer to the dependent variable dDLRGDP and in cases where the error correction model is highly restricted, these measures could become negative.

4.3 Interpretation of the Result

Thus the regressors in this equation explain over 59% of the systematic variation in long-run economic growth during the 53 year period, 1961 through 2013. This is an indication that 41 percent systematic variation long-run economic growth was accounted by total factor productivity (TFP). TFP represents the productivity of capital and labor and reflects things like the state of technology and its diffusion, the human capital of the workforce, the strength of economic and political institutions, the sectoral composition of output, and the efficient use of both capital and labor. This equation has an F-statistic of 81.2853 (with a p-value of 0.000).

Therefore, the hypothesis of a log linear relationship between the long-run economic growth and the explanatory variables in the equation cannot be rejected at the 1 percent confidence level. The ECM (error correction mechanism) has a negative sign as expected and with a t-statistic of -19.7079 has passed the significance test at the 1% confidence level.

The stock of capital and labor force (economically active population) during the period under study do not pass the test of significant even at 12%; only one period lag of real gross domestic product is significantly different from zero at the 1% confidence level. The stock of capital is correctly signed except labor force. The result of this research is free of autocorrelation.

5 Policy Implication of the Empirical Analysis

From the result it is shown that Solow's residual popularly refer to as total factor productivity accounted for about 41%; meaning the 59% of the changes in the long-run economic growth in Nigeria is driven by stock of capital and labor force, any economy controlled by contribution of stock of capital and labor force, going by growth accounting methodology will be unsustainable in the long-run, this is a clear indication of what is happening in the growth process in Nigeria.

Too much dependent on capital stock and force is responsible for extensive growth process experienced in the period under study. For any economy to experience intensive growth pattern simply put, sustainable long-run growth rate; total factor productivity play a significant role. Little wonders the stock of capital and labor force in this research is significantly not different from zero even at the 12% confidence level. It is a reflection of the true state of the Nigerian economy. With this finding, it is an indication that the country is suffering from divergent oscillatory growth tragedy.

But the technology which sustains the economy has not been given attention it deserved more so, human capital development that is the engine room of generating innovation and invention has not received proper attention by both government and private sectors.

6. Conclusions and the Way Forward

The Nigerian government should be committed to technological investment that will generate creativity, innovativeness and inventiveness which are basic medium that drive technological advancement and that is what we refer to as Solow's residual in growth accounting and is the engine of long-run economic growth.

That notwithstanding initial physical capital investment upon which the technology can thrive, should be put in place to give the economy adequate momentum to take-off.

The promotion and other benefits in public civil service in Nigeria should be tied to productivity, higher academic qualification rather the current practices where promotion is based on the year in service and nepotism. Additional, educational qualification and on the job training which are long-run growth enhancing need to be a top priority of government at all levels.

References

Abramovitz, M. (1956) .Resource and Output Trends in the United States since 1870. *American Economic Review, Papers and Proceedings of the American Economic Associations, 46, pp. 5-23.*

Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind. *The Journal of Economic History, (46), No. 2 pp. 385-406.*

Amor, T., Dhaneshwar, G., Bernardin, A., & Emmanuel, B. A. (2004). Sources of Growth in Sub-Saharan Africa. *IMF Working Paper*, *African Department; International Monetary Fund, WP/04/176*

Arrow, K. (1962). The Economic Implications of Learning by Doing. *Review of Economic Studies*, 29 (3), pp. 155-73.

Arrow, K. (1991). Returns to Scale, Information and Economic Growth. **In**: KDI (Korea Development Institute). *The 20th Anniversary Symposium on Economic Growth of Developing Countries 1940s-1980s*. Seoul.

Aykut, k. & Selahattin, D. (2001). Long-run Economic Growth: an Interdisciplinary Approach*; Department of Economics, University of Illinois at Urbana-Champaign. Second version May,2 2001* ***URL:*** *http://www.business.uiuc.edu/Working_Papers/papers/01−0121.pdf*

Bosworth, B., & Susan M. Collins, (2003). The Empirics of Growth: *An Update, (unpublished draft; Washington: Brookings Institution).*

Crafts, N. & K. O'Rourke (2013).Twentieth Century Growth, *Discussion Papers in Economic and Social History*, No. 117, September 2013.

Dike, E. (1995). Sources of Long-run Economic Growth, *African Development Review, 76-87, June.*

Easterly, W. & R. Levine, (2001). It's Not Factor Accumulation: Stylized Facts and Growth Models. *World Bank Economic Review, 15 (2), pp. 129-158.*

Edquist, C. (2005). Systems of Innovation. **In**: J. Fagerberg, D. C. Mowery and R. R. Nelson, eds. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Hsieh, C. & P. Klenow, (2007). Misallocation and Manufacturing TFP in China and India, *NBER Working Paper No. 13290.*

Iyoha M. A. (2000). The Sources of Economic Growth in Nigeria, 1960-1997: A Growth Accounting exercise. *The Nigerian Economic and Financial Review, Vol.5 No.2 December*.

Jerzmanowski, M. (2006). Total Factor Productivity Differences: *Appropriate Technology vs. Efficiency, European Economic Review*

Jones, C. & J. Williams (1998) Measuring the Social Return to R&D. *Quarterly Journal of Economics*, 113 (4), pp. 1119-1135.

Krugman, P. (1997) .*The Age of Diminished Expectations*. Cambridge: MIT Press.

Mankiw, N. G., Romer, D. & D. Weil (1992). A Contribution to the Empirics of Economic Growth *Quarterly Journal of Economics*, 107 (2), pp. 407-437.

Mokyr, J. (2002). The Gifts of Athena: Historical Origins of the Knowledge Economy. New York: Princeton University Press.

North, D. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

Ogilvie, S. & A. Carus, (2014). Institutions and Economic Growth in Historical Perspective In: P. Aghion and S. Durlauf eds. *Handbook of Economic Growth: Volume II*. Amsterdam: Elsevier Press.

Romer, P. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94 (5), pp. 1002-1037.

Romer, P. (1987). Growth Based on Increasing Returns Due to Specialization. *American Economic review*, 77 (2), pp. 56-62.

Romer, P. (1990) .Endogenous Technological Change *Journal of Political Economy*, 98, pp. 71-102.

Rosenberg, N. (1972) Factors Affecting the Diffusion of Technology. *Explorations in Economic History*, 10 (1), pp. 3-33.

Senhadji, A. (1999). Sources of Economic Growth: An Extensive Growth Accounting Exercise. *IMF Working Paper 99/77. Washington D.C.: International Monetary Fund.*

Senhadji, A. (2000). Sources of Economic Growth: An Extensive Growth Accounting Exercise. *Staff Papers, International Monetary Fund, Vol. 47, No.1, pp. 129-57*

Snowdon, B. & H. Vane (2005). *Modern Macroeconomics: Its Origins, Development and Current State*. Cheltenham: Edward Elgar.

Solow, R. M. (1956) A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, 70, pp. 65-94

Solow, R. M. (1957). Technical Change and Aggregate Production Function. *Review of Economics and Statistics, 39, August, 312-20.*

Thomas, A. M., (2013). The Economics of Broadband in Ireland: Country Endowments, Telecommunications Capital Stock, and Household Adoption Decisions. *NUI Galway, PhD Thesis. Galway: J.E. Cairnes School of Business and Economics.*

Thomas, A. M., (2015). Cultivating Long-Run Economic Growth in the Republic of Ireland. *(NERI) Nevin Economic Research Institute, Dublin, Ireland, NERI working paper series see: www.NERInstitute.net*

Whitt, R. (2009). Evolving Broadband Policy: Taking Adaptive Stances to Foster Optimal Internet Platforms. *CommLaw Conspectus*, (17) No. 417, pp. 417-534.