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RESEARCH ARTICLE

STEADY STATE ECONOMY IN A CROWDED WORLD: A CASE OF NIGERIA

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ABSTRACT

Economic growth, with all of its downsides, is clearly unsustainable in the 21st century. The positive, sustainable alternative is a Steady-State Economy. This study empirically analyze show far the Nigerian economy has converged towards or diverged from steady-state. Unit root, co integration, vector error correction, and Granger causality/block exogeneity Wald tests procedures are applied on annualdata set from 1970-2013.Themodel reveals having a self-adjusting apparatus for rectifying any deviance of the variables from equilibrium. The implication is that Gross Domestic Product will reach its steady-state in approximately 1.5years, interest rate in 20years, depreciation of capital and population will be converging back to their equilibrium in 27-28years, and in 63years respectively. The sluggish rate of the variables convergence can be explained by complex administrative and political processes, therefore, in avoiding afailed state situation, it is expected of government to build strong institutions and processes, while applying some transformative economic and social policies.

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INTRODUCTION

Perpetual economic growth is neither possible nor desirable. Growth, especially in wealthy nations, is already causing more problems than it solves. Recession is not sustainable or healthy either. The positive, sustainable alternative is a steady state economy(CASSE, 2015). David Orr says, "Growth for the sake of yet more growth is a bankrupt and eventually lethal idea. Center for the Advancement of the Steady State Economy "CASSE" is the David fighting the Goliath of endless expansion, and we know how that one turned out." Economic growth, with all of its downsides, is clearly unsustainable in the 21st century. Therefore, it should be clear by now that economic growth was never a magic bullet; it is simply an increase in the production and consumption of goods and services–it cannot possibly lead to a sustainable outcome. In contrast, the steady state economy provides the means for present and future generations to achieve a high quality of life (CASSE, 2015). Due to the disequilibrium of Gross Domestic Product (GDP), some scholars have suggested change in the measures of progress: since GDP is only an indicator that shows the value of all transactions taking place across an economy, without differentiating 'good' transactions (investment in public transport) from bad (the costs of cleaning up an oil spill); nor does it measure distribution, irreplaceable resource use, take into account unpaid activity such as household work or community initiatives; it is even terrible at measuring pollution and so on(Quaker, 2011; Worstall, 2014). It is for this reason that numerous alternative indicators such as the 'Happy Planet Index' and the 'Genuine Progress Indicator' have been created and are being monitored, even if only few governments see them as a serious alternative to GDP. Many economists including Arthur Okun argue that increase in output (GDP) will create more jobs. It is also common knowledge that technology innovation can augment both labor and capital productivity to increase the volume of output, but might result in cyclical or deficient-demand unemployment. Therefore, if we were to secure full employment, we will have inflation to content with. It is all about give and take, but if we are not too desperate to the extent of "growth or die "syndrome; then we will see that life gets better in a steady state economy as long as total factor productivity increases. The neoclassical model, often called the Solow growth model and sometimes called the steady state model, that was advanced by (Solow , 1956), and later relaxed some of the simplistic assumption of the Harrod-Domar models; has been criticized by (Schumpeter, 2006) that it failed to offer a satisfactory account of the links between savings and growth which conforms to conventional wisdom that capital accumulation is the engine of growth. This model however

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assumes that countries use their resources efficiently and that there are diminishing returns to capital.

From the above principles, the model makes three important predictions: 1), expanding capital with respect to labor creates investment development, since individuals might be more gainful given more capital. 2), poor countries with less capital per person will grow faster because each investment in capital will produce a higher return than rich countries with ample capital. 3), due to consistent losses to capital, economies will inevitably achieve a focus at which no new increase in capital will create output or economic growth. Thus, diminishing marginal product is the key explanation of why the economy reaches a steady state rather than growing endlessly. It all comes down to balance; economies may grow or contract, but eventually fight back to equilibrium. However, there remain unanswered questions as to how a steady state economy might be achieved, whether it is still relevant in today's economic environment, and whether it is a desirable part of the sustainability paradigm (Anderson, 2012). The answer is not far fetch, this state of economy may be pursued in the policy arena with the same policy tools that have historically been used to facilitate economic growth. These include fiscal policy tools such as government spending and taxation, and monetary policy tools such as money supplies, exchange rate and interest rates (Czech, 2006). This article is structured as follows: The next section presents literatures review-how stationary state evolves overtime into steady state economy. Section three highlights the methodology employed, the sources of data and variables testing. Empirical results and analysis will be done in the fourth section while the discussion is completed by conclusions and policy recommendation in section five.

LITERATURE REVIEW

The steady state concept is rooted in classical economic theory and is most clearly formulated in a short section in *Principles of Political Economy* of John Stuart Mill. The idea of the end of development puzzled Mill to examine the imperative of progress, and by so doing emphasizing that "the increase in wealth is not boundless," an early expression that is now known as the limits-to-growth argument. The argument that the end of progress must result in dire or depressing consequences was too much for him to accept. He did acknowledge that economic growth was necessary for an increasing population to avoid degrading the poorest of those in society; however he is not of the opinion that growth was obligatory in order for the underprivileged to have their share in the benefits of society, which they could and must do. Rather than following other classical economists' assumption of a world with great consequences due to the end of economic growth, he made stationary state the way forward. Stationary state for him is what he called "equality of fortunes" - a stationary population and shared benefits of the economy.

Mill was in-line with Malthus, by assuming the possibility of an increase in human population. His idea of stationary or steady state might not be in-line with the growth theories of early twentieth century, but the concept was used in a technical sense, illustrated by (Samuelson, 1943). The steady state economy was considered as equilibrium situation that is necessary to be understood in terms of capital formation and depreciation, interest rates, and the business cycle. There has not been a clear development of Mill's thought into a modern version of the steady state. Rather, there are multiple elements of intellectual development that sometimes, borrow from one another. Following the Malthusian trap of geometric growth in population versus arithmetic growth in food supply, (Osborn, 1948; Vogt, 1948) and others suggested a link between a steady state economy and a stationary population as a model for understanding the changes facing the world after the cataclysm of World War II. They planted the seeds that eventually grew into several different but interweaved strains of steady state economics. These included Georgescu-Roegen's application of entropy to economic processes, and Daly's explicit steady state economics. According to Herman Daly, one of the founders of the field of ecological economics and a critic of neoclassical economics, a steady state economy is:

"An economy with constant stocks of people and artifacts, maintained at some desired, sufficient levels by low rates of maintenance "throughput", that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption." A steady state economy, therefore, aims for stable or mildly fluctuating levels in population and consumption of energy and materials. Birth rates equal death rates, and production rates equal depreciation rates. For that reason, the critical elements in the transition process are the rate of saving and investment compared with the rate of depreciation and population. Inasmuch as the environment cannot support an unlimited growth of production and wealth, then a growing population will eventually push down wages and use up an increasingly scarce base of natural resources.

Daly is not the only one that recognized the connection between physical laws and economic activity; he actually got his inspiration from his professor and mentor, Nicholas Georgescu-Roegen, a Romanian American mathematician, statistician and economist, whose insight was that the second law of thermodynamics, the entropy law, determines what is possible in the economy. Georgescu-Roegen went further to say that useful, low-entropy energy and materials are dissipated in transformations that occur in economic processes, and they return to the environment as high-entropy wastes. The economy, then, functions as a conduit for converting natural resources into goods, services, human satisfaction, and waste products. Increasing entropy in the economy sets the limit on the scale it can achieve and maintain (Georgescu-Roegen, 1971). Daly built upon his mentor's work and combined limits-to-growth arguments, theories of welfare economics, ecological principles, and the philosophy of sustainable development into a model he called steady state economics. It is never enough to have sufficient of good thing. Therefore, "if we agreed that economic output is a good thing, it follows by definition that there is not enough of it" (President Council of Economic Advisers, 1971).This is why E. F. Schumacher made his economic model to be grounded in sufficiency of consumption, opportunities for people to participate in useful and fulfilling work, with vibrant community life marked by peace and cooperative endeavors(Schumacher, 1973). John Maynard Keynes considered the day when society could focus on ends rather than means. In his word: The day is not far off when the economic problem will take the back seat where it belongs, and the arena of the heart and the head will be occupied or reoccupied, by our real problems – the problems of life and of human relations, of creation and behavior and religion(Keynes, 1963). In order to understand our current day economic situations, we have to go back to John Stuart Mill and the earlier classical economists to find serious treatment of the idea of a non-growing economy, the Stationary State.

MATERIALS AND METHODS

This paper uses a Vector Auto Regression to identify the relationship between economic growths (steady state), interest rate, population growth, and rate of depreciation. The empirical investigation is based on sample covering the period of 1970 to 2013.

Model Specification

This paper explores a linear relationship between variables. Following the standard literature, the model is based on the following equation:

$Y = f(IR, POP, DEP)$…………………….. (1)

In an explicit and econometric form, equation (1) can be stated as:

$Y_t = \beta_0 + \beta_1 IR_t + \beta_2 POP_t + \beta_3 DEP_t + \varepsilon_t$ ………………(2)

Where; Y_t is Economic growth (GDP), IR_t is interest rate, POP_t is the population growth rate,DEP_t is depreciation rate (% of domestic demand), β_0 is the constant term called the intercept and, β_1, β_2 and β_3, are the coefficients of the regression equation. "t" is the time trend, and "ε_t" is the stochastic random term. Data used for this analysis is for 44 years from 1970 to 2013 for Nigeria from World Development indicators (2013), World Bank website. Interest rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector. This rate is normally differentiated according to creditworthiness of borrowers and objectives of financing. Depreciation rate or consumption of fixed capital represents the replacement value of capital used up in the process of production. According to the 2008 manual of the United Nations System of National Accounts, consumption of fixed capital is the decline, during the course of the accounting period, in the current value of the stock of fixed assets owned and used by a producer as a result of physical deterioration, normal obsolescence or normal accidental damage. The term depreciation is often used in place of consumption of fixed capital but it is avoided in the System of National Accounts "SNA" because in commercial accounting the term depreciation is often used in the context of writing off historic costs whereas in the SNA consumption of fixed capital is dependent on the current value of the asset (UNstats, 2009). We might assume that depreciation is 10% per year, so every year 10% of the capital stock needs to be replaced to offset wear and tear.

Estimation Technique

The structural approach to time series modeling uses economic theory to model the relationship among the variables of interest. Unfortunately, economic theory is often not rich enough to provide a dynamic specification that identifies all of these relationships. Furthermore, estimation and inference are complicated by the fact that endogenous variables may appear on both sides of equations. These situations lead to alternative, non-structural approaches to modeling the relationship among several variables. We investigated the time series characteristics of the data to test whether the variables are integrated. The finding that many macro time series may contain a unit root has spurred the development of the theory of non-stationary time series analysis. Engle and Granger (1987) revealed that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables. If cointegration is detected, Vector Error Correction (VEC) or non-stationary regression methods may be used to estimate the cointegrating equation. But first, in order to test the analyzed stationary variables, the Augmented Dickey-Fuller (ADF) test and Philip and Perron (PP) will be applied. Given an observed time series $Y_1, Y_2 \ldots Y_N$, Dickey and Fuller consider three differential-form autoregressive equations to detect the presence of a unit root:

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{j=1}^{p}(\delta_j \Delta y_{t-j}) + e_t \ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{j=1}^{p}(\delta_j \Delta y_{t-j}) + e_t \ldots\ldots\ldots\ldots 3.2$$

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{j=1}^{p}(\delta_j \Delta y_{t-j}) + e_t \ldots\ldots\ldots 3.3$$

Where "t" is the time index, α is an intercept constant called a drift, β is the coefficient on a time trend, γ is the coefficient presenting process root, i.e. the focus of testing, p is the lag order of the first-differences autoregressive process, and e_t is an independent identically distributes residual term. The ADF test ensures that the null hypothesis is accepted unless there is strong evidence against it to reject in favor of the alternate stationarity hypothesis. Due to the possibility of structural breaks which makes the ADF test questionable for testing stationarity, with the fear of biasness towards non-rejection of the null hypothesis of a unit root. The regression equation for the PP test is given by:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

The presence of a unit root will indicate the need for further analysis. Thus, we may wish to adopt more sophisticated statistical models. These techniques deal with basic time series, cointegrating regression models, and vector error correction specifications. Johansen Cointegration Test: Econometrics views (Eviews) supports VAR-based cointegration tests using the methodology developed in (Johansen, 1991 & 1995) performed using a group object or an estimated Var object.

Consider a VAR of order

$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + Bx_t + \epsilon_t$ …………….5.1

Where Y_t is a k-vector of non-stationary I(1) variables, x_t is a d-vector of deterministic variables, and ϵ_t is a vector of innovations. We may rewrite this VAR as,

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + B x_t + \epsilon_t \quad \text{………..5.2}$$

$$\text{Where:} \Pi = \sum_{i=1}^{p} A_i - I, \; \Gamma_i = -\sum_{j=i+1}^{p} A_i \quad \text{……………...…..5.3}$$

RESULTS

We began the analysis by conducting a unit root test to check for the stationarity of the variables. With the exception of POP in PP unit root test at 1st difference, all other variables in the time series data have been transformed. However, we need not to be bothered, since the non-stationary time series in Y_t can be cointegrated if there is a linear combination of them that is stationary or I(0). Therefore, the null hypothesis of unit root is rejected and we can safely conclude that the variables are stationary.

Table 1. Unit Root at Level

ADF(intercept)					PP(intercept)			
Test critical values:	Y	DEP	IR	POP	Y	DEP	IR	POP
Test Statistic	-5.738	-1.249	-1.693	-0.953	-5.747	-1.149	-1.655	-2.413
1%	-3.592	-3.593	-3.592	-3.627	-3.592	-3.592	-3.592	-3.592
5%	-2.931	-2.931	-2.931	-2.946	-2.931	-2.931	-2.931	-2.931
10%	-2.604	-2.604	-2.604	-2.612	-2.604	-2.604	-2.604	-2.604

Source: Author's Estimation using Eviews 7.1.

Table 2. Unit Root at First difference

ADF(intercept)					PP(intercept)			
Test critical values:	Y	DEP	IR	POP	Y	DEP	IR	POP
Test Statistic	-8.695	-7.118	-7.259	-3.922	-13.983	-7.222	-7.273	-2.393
1%	-3.601	-3.597	-3.597	-3.627	-3.597	-3.597	-3.597	-3.597
5%	-2.935	-2.933	-2.933	-2.946	-2.933	-2.933	-2.933	-2.933
10%	-2.605	-2.605	-2.605	-2.612	-2.605	-2.605	-2.605	-2.605

Source: Author's Estimation using Eviews 7.1.

Table 3. Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.714623	75.71434	47.85613	0.0000
At most 1	0.249501	24.30267	29.79707	0.1879
At most 2	0.181813	12.53498	15.49471	0.1330
At most 3 *	0.099735	4.307727	3.841466	0.0379

Table 4. Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.714623	51.41167	27.58434	0.0000
At most 1	0.249501	11.76769	21.13162	0.5707
At most 2	0.181813	8.227251	14.26460	0.3561
At most 3 *	0.099735	4.307727	3.841466	0.0379

**MacKinnon-Haug-Michelis (1999) p-values

Table 5. Vector Error Correction Model

Error Correction:	D(Y)	D(DEP)	D(IR)	D(POP)
CointEq1	-0.681071	0.036106	-0.049361	0.015870
Standard errors	(0.27014)	(0.02677)	(0.10145)	(0.00034)
t-Statistics	[-2.52120]	[1.34894]	[-0.48655]	[4.65235]

The result in (Table1) shows that most of the variables (with the exception of Y) arenon-stationary at levels, in both ADF and PP test statistics with the critical values at the 1%, 5% and 10% level of significance. Notice here that the statistic $t_\alpha$value for IR, DEP and POP are greater than the critical values so that we do not reject the null at conventional test sizes. Unfortunately, non-stationary data, as a rule, are unpredictable and cannot be modeled or forecasted since the result from such time series may be spurious. In order to receive reliable results consistently, the solution to the problem is to transform the time series data so that it becomes stationary. Following the above result, Table 2 reveals a first difference result of the

Having satisfied with the stationarity of the variables at I(1), we can proceed to determine the long run relationship of the variables after obtaining the optimum lag since regression with I(1) data only makes sense when the data is cointegrated. We employed the Johansen's methodology of multivariate cointegration test at 2 lag intervals in first difference with linear deterministic trend. Engle and Granger (1987) showed that cointegration implies the existence of an error correction model of the form that describes the dynamic behavior of ΔY. The error correction model links the long-run equilibrium relationship implied by cointegration with the short-run dynamic adjustment mechanism that describes how the variables react when they move out of long-run equilibrium. To determine the number of cointegrating relations *r* conditional on the assumptions made about the trend, we can proceed sequentially from r=0 to r=k-1 until we fail to reject. The result of this sequential testing procedure is reported at the bottom of each table. The trace statistic reported in (table 3) tests the null hypothesis of *r* cointegrating relations against the alternative of *k* cointegrating relations, where *k* is the number of endogenous variables, for r = 0,1,…., k-1 . The alternative of *k* cointegrating relations corresponds to the case where none of the series has a unit root and a stationary VAR may be specified in terms of the levels of all of the series. Table 4 reports the Max-eigenvalue statistic which tests the null hypothesis of *r* cointegrating relations against the alternative of r+1 cointegrating relations. Trace and Max-eigenvalue test indicates one cointegrating equation each at the 0.05 level, denoting rejection of the hypothesis at the 0.05 level. The implication of the result in the above tables (3 & 4) is that there exists a long-run relationship between Y and its determinants;hence we can go ahead to estimate the error correction model to determine the speed of adjustment in the short-run to its long run equilibrium state. Since the set of variables are found to have three cointegrating vectors then a suitable estimation technique is a VECM (Vector Error Correction Model) which adjusts to both short run changes in variables and deviations from equilibrium. The intuition is that I(1) time series with a long-run equilibrium relationship cannot drift too far apart from the equilibrium because economic forces will act to restore the equilibrium relationship. In principle, the speed of adjustment parameters α(Y) (the coefficients on "cointeq1") should be negative and lie between (0, -1). This is because in a VEC model, the point estimate should imply that output (Y) in time "t" converges to the long-run equilibrium relationship – if Y is above its long-term value (ECM term >0), Y must decline (α(Y) <0) and if Y is below its long-term value (ECM term <0), Y must rise (α(Y) <0). Therefore, the negative signs of the estimated coefficient of the variables imply that the series cannot drift too far apart, and convergence will be achieved in the long run. The estimated coefficient of GDP (-0.6811), shows the speed at which it converges to its long run equilibrium (Steady state). This means that, 68.1% of this disequilibrium is corrected in 1 year. The -0.0494 estimated coefficient of IR, is implying that interest rate is moving towards its steady state by 4.9% each year. Depreciation rate of the economy and the population estimated coefficient suggest that they are diverging from steady state and require converging back to equilibrium with 0.0361 and 0.0159 estimated coefficient respectively. Meanwhile, unidirectional Granger causality runs independently from GDP and interest rate to population. And all determinants variables(Y, IR & DEP) taken together also granger cause population in the short run. Below is the cointegrating long run equation with all variables positively significant at 5% significance level:

Y= - 67.4035 + 0.9714(IR) + 20.0386(POP) + 0.8438(DEP)
Standard errors (0.1692) (6.1542) (0.3910)
t-statistics [-5.7422] [-3.2561] [-2.1582]

Conclusion

In a world of limits, if macroeconomic grow this left unchecked, it will continue to do irreparable damage to our environment, and diminish or destroy its capacity to provide the sinks, materials, energy and services necessary to support an industrial society (Mann, 2002), and economic growth would no longer be sustainable. Diminishing marginal product is the key explanation of why the economy reaches a steady state rather than growing endlessly. It all comes down to balance; economies may grow or contract, but eventually fight back to equilibrium. The purpose of this study is to empirically analyze how far the economy has converged towards or diverged from steady state. The result shows the presence of a unit root in majority of the variables, indicating the need for further analysis, and finally becomes stationary at first differencing and integrated of I(1). Then we adopted more sophisticated statistical models in the form of cointegrating regression models, vector error correction specifications and VEC granger causality/block exogeneity Wald tests. The dynamic causal interactions among the variables which is phrased in a vector error correction form, allows us to assess both long-run and short-run causalities. Hence, these analyses reveal both short run and long run relationship among the variables. The vector error correction test indicates that the model has a self-adjusting mechanism for correcting any deviation of the variables from equilibrium. The implication of this is that GDP will reach its steady state in approximately 1.5 years, interest rate in 20 years, depreciation of capital and will be converging back to its equilibrium in 27 to 28 years, and population in 63 years.

The sluggish rate of the variables convergence towards equilibrium can be explained by complex administrative and political procedures. Overshooting of the depreciation rate can be accounted for as the loss in capital value of the Naira (Nigerian currency) owing to its official devaluation, double digit inflation, structural adjustment in the 1980s, investment concentration in the capital market and the oil and gas industry, causing a higher cost for capital goods in production. The way forward to archive an increase in the GDP-Population ratio is for the capital stock to grow faster than the population and depreciation. The higher the saving rate chosen by a society, the higher the steady state capital and income; meanwhile a higher capital will lead to greater investment requirement to maintain the GDP-Population ratio, as opposed to being used for current consumption.

In order to get faster to equilibrium or overcome steady state, Nigeria would have to avoid the characteristics of a failed economy which usually include higher unemployment, poverty and government debt. There is also a need for investment in new technology that allows production with fewer resources and investing in human capital to augment both labor and capital productivity in increasing the volume of output. In avoiding the harmful characteristics of a failed state, it is expected for government to build strong institutions and processes, while applying some transformative economic and social policies such as 1) limiting resource use and waste, 2) limiting inequality, 3) stabilizing population by balancing immigration and birth rates with emigration and death rates, 4) reforming monetary policies – potentially a 'full reserve' system where banks could only lend in accordance with their available deposits, and 5) improving the infrastructural facilities to augment the existing ones.

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