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COINTEGRATION APPROACH: A SOLVENCY FOR PUBLIC DEBT

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ABSTRACT

This paper seeks to determine whether cointegration can be apply to Nigerian public debt and the short run dynamics of government revenues and expenditures for annual data from 1985 to 2013 for solvency. Sustainability of government finances suggests that governments can continue with the existing fiscal policies indefinitely and remain solvent. Using unit root and cointegration tests, the conclusion is that the public debt is solvent and revenues are strongly exogenous for expenditure. Further evidence is obtained from public debt to GDP which is decreasing gradually.

JEL: 62M10; H63

KEYWORDS: Unit Root, Cointegration, Revenue-Expenditure, Solvency

INTRODUCTION

In the 1970s, following the increase in the world price of oil and with oil production expanding, Nigeria seemed to be on track to prosperity. Oil revenues allowed for large investment programs, and rapidly rising government expenditures led to increasing purchasing power for significant numbers of people. In 1980, with oil export at US$26 billion and a per capital GDP of US$1480, Nigeria was considered a middle-income country and had easy access to international capital markets. However, in the course of the 1980's, economic weakness became apparent. the fall in oil production in 1981 (owing to OPEC quota changes) and subsequent oil prices decrease made it clear how dependent the economy and the government budget had become on oil revenue, rapidly building up foreign debt (in addition to the buildup of debt by the private sector through trade arrears). However, soon after the 1982 international debt crisis, Nigeria was cut off from the international capital market.

For more than 15 years, the country has owed more than $25 billion to international and commercial lenders. Just to pay the interest on the public debt took 7 percent of Nigeria's economic output in 2008. Taken as a whole, the debt — some $31 billion — represents more than 71 percent of the country's entire gross domestic product after debt cancellation or buy back form.

The situation has so crippled Nigerian economic development that when the average voter went to the polls in April 2003 to cast his ballot in the country's presidential election, he was poorer than the average Nigerian at the time of the country's independence in 1960. In 2005, before the exit debt payment to the Paris Club was made by Nigeria, total external debt service payment was $1,367.54 million made up of principal repayments of $978.36 million; and interest payments and commitment charges of $389.17 million. However, with the inclusion of a debt service payment of $7,575.92 million under the first and second phases, payment made for debt service in late 2005 was $8,943.45m. This is the highest debt service ever paid in a single year in the history of Nigeria.

Unit root and cointegration tests have provided useful tools in gaining insight into the long-run implications of a government's or nation's intertemporal solvency. Thus, researchers have attempted to test the solvency condition within the unit root and cointegration framework recently. In short, cointegration is a necessary condition for the economy to be obeying its intertemporal budget constraint. The test determines whether a government or country is likely to be able to sustain its budget or external deficits without defaulting on the debt

Literature Review and Theoretical Framework

In evaluating the sustainability of the external deficits in open economy settings, one may apply the methodology developed by Trehan and Walsh (1991). In Trehan and Walsh's procedure, the stationarity of the discounted real external debt stock is a sufficient condition for sustainability of the external deficits. Alternatively, Hakkio and Rush (1991a) propose a method in which cointegrating (long-run equilibrium) properties of the exports and imports variables are tested. In this framework, cointegration of the exports and imports variables is a necessary condition for the country to have sustainable external deficits (ie. intertemporal external solvency). Both Trehan and Walsh, and Hakkio and Rush start with a balance of payments identity, and then obeying intertemporal budget constraints, they derive some testable empirical models. Sawada (1994), e.g., gives some clear explanation about the theoretical reasons behind such empirical models. Sawada, using Trehan-Walsh and Hakkio-Rush propositions, reaches some testable sustainability conditions and applies them to some heavily indebted developing countries to evaluate their external solvency. Recently, some works such as Bean (1991), Dolado and Vinals (1991), Trehan and Walsh (1991), Husted (1992), Wickens and Uctum (1993), Bahmani-Oskooee (1994) analyze the sustainability of external deficits (i.e. external solvency) in developed countries. Bahmani-Oskooee and Domac (1995) applies the methodology to the growing Turkish external deficits. They are able to find evidence of cointegration between imports and exports, only when the structural break in 1973 is incorporated into cointegrating equations.

Issler and Lima (2000) and shows that there exists a long-run equilibrium between revenues and expenditures and that revenues cause expenditures in the sense of Granger. He finds no evidence of weak exogeneity for revenues or expenditures.

METHODOLOGY

In this paper, Engle and Granger (1987) cointegration procedure is employed following Husted (1992), Bahmani-Oskooee (1994) and Bahmani-Oskooee and Domac (1995). Two time series, X_t and Y_t are said to be cointegrated of order d-b, where d>b>0, denoted as

$X_t, Y_t \sim CI(d,b)$, if:

(a) Both are *I(d),* and

(b) Their linear combination $a_1.X_t + a_2.Y_t$ is *I(d-b);* that is, the residuals of the long-run regression should be stationary (i.e. integrated of order zero). The vector $[a_1, a_2]$ is referred to as the "*cointegrating vector*" (see Engle and Granger, 1987). We employ the ADF test and the residual-based ADF test to determine the integration level and the possible cointegration between the variables respectively. Therefore, in testing for cointegration we should first make sure that both series are integrated of the same order. Next we estimate the following cointegrating regressions by OLS:

$X_t = \alpha_0 + \beta_0 Y_t + u_t$ ……(2)

$Y_t = \alpha_1 + \beta_1 X_t + u'_t$ ……(3)

Finally, we test for the stationarity of the residuals from equations 2 and 3 to make sure that u_t and $u'_t \sim I(d-b)$, where b>0. e.g. if $X_t \sim I(1)$ and $Y_t \sim I(1)$, in order for X_t and Y_t to be cointegrated, u_t and u'_t should be I(0).

In determining the optimal lag structure in the ADF testing procedure (both for unit roots and cointegration), in addition to t-ratios, we also rely on the model selection criterions of Akaike Information, Schwarz Bayesian, Maximized log-likelihood and Hannan-Quinn since arbitrary choice of the lag structure may easily result in wrong conclusions.

Let us now outline the *augmented Dickey-Fuller* (*ADF hereafter*) test procedure for unit roots. In practice, the following model is estimated by OLS:

$$\Delta y_t = \alpha + \beta_t + \delta y_{t-1} + \sum_{i=1}^{P} \phi \Delta y_{t-1} + e_t \quad \text{……(4)}$$

Where $\Delta, \alpha, t,$ and e_t represent the first-difference operator, the constant term, the time trend, and a sequence of uncorrelated stationary error terms with zero mean and constant variance respectively. An easy and appropriate method of testing the order of integration of a series, say y_t, is suggested by Dickey and Fuller (1979, 1981). The DF test consists of testing negativity of δ in regression (1), rejection of the null hypothesis δ=0 in favour of the alternative δ<0 implies that y_t is stationary (i.e. integrated of order zero, $y_t \sim I(0)$).

TESTING FOR COINTEGRATION USING JOHANSEN'S METHODOLOGY

Johansen's methodology takes its starting point in the vector autoregression (VAR) of order

p given by

$$y_t = \mu + \Delta_1 y_{t-1} + ... + \Delta_p y_{t-p} + \varepsilon_t \quad \text{……(5)}$$

Where y_t is an *n*x1 vector of variables that are integrated of order one – commonly denoted

I(1) – and ε_t is an *n*x1 vector of innovations. This VAR can be re-written as

Where $\Pi = \sum_{i=1}^{p} A_{i-1}$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$ ……(6)

If the coefficient matrix **Π** has reduced rank *r*<*n*, then there exist *nxr* matrices **α** and **β** each with rank *r* such that **Π** = **αβ′** and *t* **β′y** is stationary. *r* is the number of cointegrating relationships, the elements of **α** are known as the adjustment parameters in the vector error correction model and each column of **β** is a cointegrating vector. using the Hakkio and Rush (1991) approach, we follow two approaches here. The univariate analysis is carried out via the classical Box and Jenkin's methods applied to the difference revenues-expenditures and cointegration via ADF and Johansen's technique. In the later case one is interested in knowing whether or not there exists a constant $\beta = 0$ such that

$y_t - \beta x_t$ is a zero mean stationary process, y_t being government revenues and x_t government expenditures, and testing if β = 1. Basic to both approaches is the assumption that the primary surplus and the real interest rate series define stationary processes.

DATA ANALYSIS

The data set we use was downloaded from the Central Bank of Nigeria and consists of real annual data ranging from 1985 to 2013, on Government Expenditures (total) , which include interest payments on the government debt, Government Revenues (Total), which do not include seignorage, the Primary Surplus and the interest rate.

Figure 1(Appendix II) shows the evolution of the deficit measured by the difference between revenues (do not include seignorage) and expenditures (include interest payments on the government debt). The process is clearly stationary but the mean level seems to be negative. Indeed the process is well fit by the AR (12) process

$$def_t = \mu + \alpha def_{t-12} + \varepsilon_t$$

Where $\hat{\mu} = 65.089$ (12.44) and $\hat{\alpha} = 0.211(0.008)$

And $\mu \neq 0$ at the 5% level. This is indication of lack of sustainability.

In the context of the Johansen's approach, we now proceed with the inspection of weak exogeneity of the variables under analysis. Table 2(appendix I) presents the results of this statistical exercise with 2 lags. Government revenues are not so weakly exogenous for government expenditures.

Table 4(appendix I) finally show Granger causality test and the direction of causality detected is from government revenues to government expenditures. The results are robust relative to the choice of lags. It follows from our statistical exercise that government revenue is strongly exogenous. This means that the equation of expenditure as function of revenue can be used for forecasting purposes.

SUMMARY AND CONCLUSIONS

Using techniques related to univariate Box and Jenkin's analysis and cointegration of time series we have shown that the government debt can be considered sustainable in the long run using data ranging from 2008 to 2013. Each of the deficit measures considered in the paper reveals a different facet of fiscal health and governments (consolidated) have scored poorly on some of the indicator. Unsustainability of the revenue deficit and the external debts, viewed alongside the sustainability of the primary or non-interest deficit as ratio of GDP is a pointer that the federal government' need to be cautious whilst resorting to borrowing to finance current expenditure

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APPENDICES

Table 1: ADF Results

Series	Lag	ADF	P-Values
Revenues	2	-1.434	0.544
Δ **Revenues**	1	-10.862	<0.001
Expenditure	3	-1.875	0.486
Δ **Expenditure**	2	-9.459	<0.001

Table 2: Johansen's Test

Variable	Rev/GDP	Exp/GDP	Ext. Debt/GDP	Ext. Debt/Expt
Trace statistics	8.90	8.11	7.07	20.82
Max eigen value	8.32	7.86	8.02	19.14
Lags	1	1	1	1
Critical Values: 5% level of significance: Trace Stat: 15.41, Max Eigen Stat: 14.07 # At 1% level of significance: (ii) Trace Stat: 20.04, Max Eigen Stat:18.63				

Table 3: Test of Weak Exogeneity

Variable	Chi-square	DF	P Value
Revenues	1.53	1	0.245
Expenditure	3.84	1	0.105

Table 4:Granger Causality Test

Null Hypothesis	Observation	F-Statistics	P-Value
The revenue does not (Granger) cause expenditure	40 (2 lags)	4.5	0.011
The expenditure does not (Granger) cause revenue		0.522	0.354

Table 5: Summary of Cointegration Tests

Variable as Ratio to GDP	ADF Test	Johansen's Test	Result	Prognosis
Revenue Deficit	X	X	No Cointegration	Not sustainable
Export deficits	X	√	Cointegration	Sustainable
External debt	X	X	No Cointegration	Not sustainable
Exports	√	√	Cointegration	Sustainable
Overall Gap	√	√	Cointegration	Sustainable
X denotes no cointegration		**√ Denotes cointegration**		

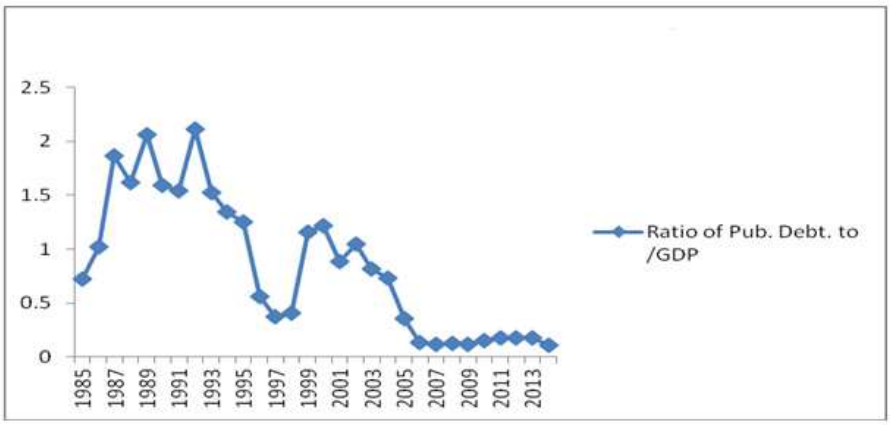

Figure 1: Ratio of Pub. Debt to/GDP

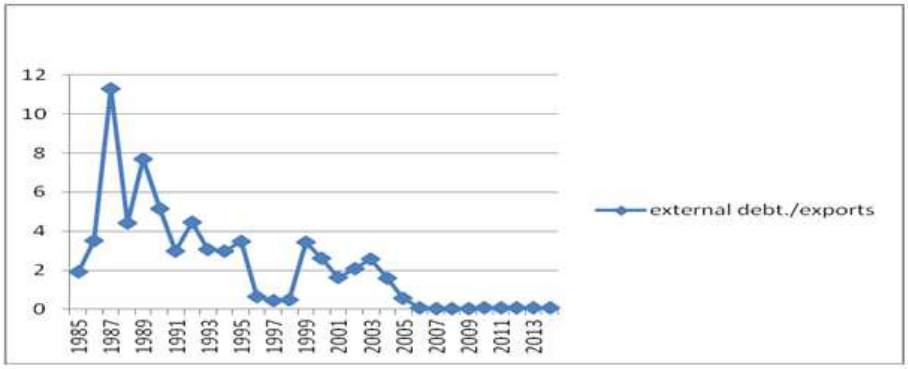

Figure 2: External Debt./Export

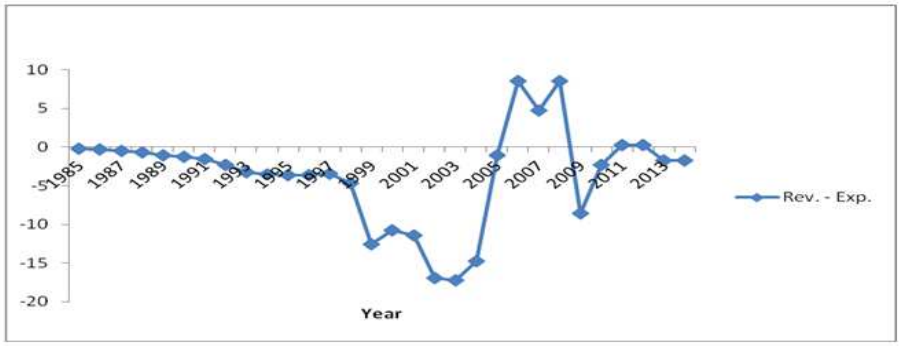

Figure 3: Evolution of Deficit (Rev.-Exp.)