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Currency Substitution in Nigeria

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ABSTRACT

This paper investigates whether depreciation of the domestic currency in Nigeria has resulted in currency substitution away from the Nigeria Naira. By conducting cointegration test, we have tested for a long-run relationship between M2, real income, nominal interest rate and nominal effective exchange rate over the period 1986 to 2010. Empirical results suggest that depreciation of the Naira has resulted in a decline in holding of M2 indicating the presence of currency substitution in Nigeria.

Keywords: Currency substitution; Cointegration and Time Series

INTRODUCTION

The phenomenon of currency substitution, whereby the residents of one country hold foreign as well as domestic currencies in their portfolios, has assumed growing importance in recent years. Currency substitution, it has been argued, is a critical factor in the volatile behaviour of exchange rates. It has also been shown to have radical implications for monetary policy, undermining the basis for targeting domestic monetary growth and giving more emphasis to intervention in the foreign exchange market.

Currency substitution has important implications for the macroeconomic performance of countries, financing government deficit, determining an appropriate foreign exchange regime, and conducting the monetary policy. Currency substitution, leading to the decline in domestic money holdings, could cause an economic slowdown and hence worsen the economic crisis [1]. Following currency substitution, an increase in the size of foreign currency deposits leads to a decline in the amount of credits in domestic currency forcing domestic private firms to borrow in foreign currencies. This increases the currency and default risks of firms making them more vulnerable to speculative activities. In addition, borrowing in foreign currency leads to an increase in the domestic currency value of foreign currency debt obligations in the face of devaluation. This causes an increase in the demand for foreign currency and, in turn, may result in a downward spiral in the price of domestic currency [2]. These will of course weaken the macroeconomic stability in the overall economy [3]. Currency substitution could also cause widening in budget deficits since *seigniorage* income is the main source of income for the government, particularly in high inflation economies. In case, this loss of income is not compensated by increasing taxes or reducing government spending, currency substitution may further increase the rate of inflation [4].

The rest of this paper is organized as follows. Section two reviews related literatures while section three provides econometric methodology and data employed in the empirical analysis of currency substitution. Section four presents the result and empirical analysis of the subject and section five concludes

LITERATURE REVIEW

Miguel (2006)[5] tested the stability of the demand for money in the euro-area in the context of an open economy. A sample consisting of quarterly data covering the 1982:2–1999:3 period was considered. The main finding is that the U.S. dollar long-term interest rate plays a significant role in the European money demand relationship. The result holds for different combinations of variables forming the vector auto-regressive system and suggests that international monetary interdependency may be an important factor influencing the ECB monetary policy [6].

Buchs *et al.* (2000)[7] investigated currency substitution and its effect on exchange rate instability in Turkey. Using an exponential GARCH (E-GARCH) model, they found evidence of currency substitution and also found that exchange rate instability increases with the degree of currency substitution

In their study on Thailand, Bahmani-Oskooee and Techaratanachai, (2001)[1] examined whether currency depreciation has resulted in currency substitution away from the Thai baht. Using cointegration approach, they found that depreciation of the baht has resulted in a decline in bath holding in Thailand.

Using a similar methodology, Dontsi et al. (2001)[8] investigated whether currency depreciation in some of Latin America countries (namely Argentina, Brazil and Mexico) has resulted in currency substitution. Using the vector error correction (VEC) model, they found that currency substitution occurs to a greater extent in Argentina and Brazil than Mexico.

Bordo and Choudhri, (1982)[9] investigated the presence of currency substitution in eight African countries- Egypt, Morocco, Nigeria, Ghana, Kenya, South Africa, Tunisia and Zambia- for the period 1976 to 2005 using both regional and US dollar as anchor currencies and the cointegration methodology. The result of the study shows that currency substitution is prevalent in Ghana and Nigeria when CFA franc is used as an anchor currency. However, when US dollar is used as an anchor currency there is no evidence of currency substitution in Ghana but we still observe the presence of currency substitution in Nigeria. The study also found presence of currency substitution in South Africa but not in Egypt when the US dollar is the anchor currency. For Kenya, Tunisia and Zambia there is no evidence of currency substitution irrespective of the anchor currencies considered. In the case of Morocco, we observe no evidence of currency substitution when the Egyptian pound is used as anchor currency but there is weak evidence of currency substitution when the US dollar is considered.

Calvo and Vegh(1992),[10] investigated whether currency depreciation in Turkey has resulted in currency substitution away from the Turkish Liras (TL). By conducting cointegration test, the study tested for a long-run relationship between M1, real income, nominal interest rate and nominal effective exchange rate over the period January 1987 to August 2006. Empirical results suggest that depreciation of the TL has resulted in a decline in holding of M1 indicating the presence of currency substitution in Turkey.

Model

$$\log M2 = a + b\log Y + c \log I + d \log neer + e \text{...} (1)$$

where, , Y is the real income, and $neer$ is the nominal effective exchange rate

METHODOLOGY

MODEL SPECIFICATION

To carry out this research effectively, there is need to represent the study in a function which is thus specified:

M2 = f (Y, I, NEER) -- (2)

Represented in log-linear econometric form:

$$LM2_t = \alpha_0 + \beta_1 LY_t + \beta_2 I_t + \beta_3 NEER_t + \varepsilon_t \text{ --------------------------- } (3)$$

Where

$M2_t$ = is the real money stocks

Y_t = is the real income

I_t = is nominal domestic interest rate

$NEER_t$ = is the nominal effective exchange rate

α_0 is the constant term, 't' is the time trend, and 'ε' is the random error term.

'L' represents natural logarithm

DATA DESCRIPTION AND SOURCE

Annual time series data are used, and the sample period 1986 to 2010. All data has been taken from the

International Financial Statistics (IFS), and the Central Bank of Nigeria Statistical Bulletin. *M2* is the real money stock. Country's nominal M2 is deflated by its CPI to obtain real money supply. *Y* is the real the gross domestic product (GDP). Nominal GDP is deflated by CPI to obtain real GDP. Interest rate *(I)* is the nominal domestic interest rate. *Neer* is nominal effective exchange rate defined as units of foreign currency per unit of the Nigeria's Naira. All the data series are seasonally adjusted and transformed to logarithmic form.

ESTIMATION TECHNIQUES

The technique used in this study is the cointegration and error-correction modeling technique. To estimate the cointegration and error-correction, three steps are required: these are testing for order of integration, the cointegration test and the error correction estimation.

UNIT ROOT TEST

The unit root test involves testing the order of integration of the individual series under consideration. Several procedures has been developed for the test of order of integration including the choice for this study: Augmented Dickey-Fuller (ADF) test due to Dickey and Fuller, (1981)[11] and the Phillip-Perron (PP) due to Drakos, (2003) and Calvo and Végh, (1993)[12], [13] Augmented Dickey-Fuller test relies on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypotheses of stationarity. The tests are conducted with and without a deterministic trend (t) for each of the series. The general form of ADF test is estimated by the following regression

$$\Delta y_t = \alpha^0 + \alpha^1 y^{t-1} + \sum_{i=1}^{n} \alpha \Delta y_i + e^t \text{ ---------------------------------- (4)}$$

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{n=1}^{n} \alpha_1 \Delta y_i + \delta_t + e_t \text{ --------------------------------------- (5)}$$

Where

Y is a time series, t is a linear time trend, Δ is the first difference operator, α_0 is a constant, n is the optimum number of lags in the dependent variable and e is the random error term the difference between equation (2) and (3) is that the second equation includes just drift. However, the third equation includes both drift and linear time trend pp.

$$\Delta y_t = \alpha_0 + \alpha y_{t-1} + e_t \text{ --- } (6)$$

COINTEGRATION TEST

This is the testing of the presence or otherwise of cointegration between the series of the same order of integration through forming a cointegration equation. The basic idea behind cointegration is that if, in the long-run, two or more series move closely together, even though the series themselves are trended, the difference between them is constant. It is possible to regard these series as defining a long-run equilibrium relationship, as the difference between them is stationary [14]. A lack of cointegration suggests that such variables have no long-run relationship: in principal they can wander arbitrarily far away from each other [11]. We employ the maximum-likelihood test procedure established by Johansen and Juselius (1990) and Johansen (1991) [15],[16]. Specifically, if Y_t is a vector of n stochastic variables, then there exists a p-lag vector auto regression with Gaussian errors of the following form:

Johansen's methodology takes its starting point in the vector auto regression (VAR) of order P given by

$$y_t = \mu + \Delta_1 y_{t-1} + --- + \Delta p \;\; y_{t-p} + \varepsilon_t \text{ ------------------------------------ (7)}$$

Where

Y_t is an nx1 vector of variables that are integrated of order commonly denoted (1) and ε_t is an nx1 vector of innovations.

This VAR can be rewritten as

$$\Delta y_t = \mu + \eta_{yt-1} + \sum_{i-1}^{p-1} \tau_i \Delta y_{t-1} + \varepsilon_t \text{ --- (8)}$$

Where

$$\prod = \sum_{i-1}^{p} A_{i-1} \quad \text{and} \quad \tau_i = -\sum_{j=i+1}^{p} Aj$$

To determine the number of co-integration vectors, Johansen (1988, 1989) and Johansen and Juselius (1990) suggested two statistic test, the first one is the trace test (λ trace). It tests the null hypothesis that the number of distinct cointegrating vector is less than or equal to q against a general unrestricted alternatives q = r. the test calculated as follows:

$$\lambda \text{ trace (r) } = -T \sum_{i=r+1} \text{ In } \left(1 - \hat{\lambda}_t\right) \text{ ------------------------------------ (9)}$$

Where

T is the number of usable observations, and the $\lambda_{1,s}$ are the estimated eigenvalue from the matrix.

The Second statistical test is the maximum eigenvalue test (λ max) that is calculated according to the following formula

λ max (r, r + 1) = -T In (1 – λr + 1) --------------------------- (10)

The test concerns a test of the null hypothesis that there is r of co-integrating vectors against the alternative that r + 1 co-integrating vector.

ERROR CORRECTION MODEL

This is only carried out when cointegration is proven to exist; it requires the construction of error correction mechanism to model dynamic relationship. The purpose of the error correction model is to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium state. The greater the co-efficient of the parameter, the higher the speed of adjustment of the model from the short-run to the long-run

We represent equation (3) with an error correction form that allows for inclusion of long-run information thus, the error correction model (ECM) can be formulated as follows:

$$\Delta LM2_t = \alpha_0 + \sum_{t=1}^{n} \beta_{1t} \Delta LY_{t-1} + \sum_{i-1}^{n-1} \beta_2 \Delta I_{t-1} + \sum_{i-1}^{n-1} \beta_3 \Delta NEER_{t-1} + \lambda Ec_{t-1} + \mu_t - - - - - - - (10)$$

Where

Δ is the first difference operator

λ is the error correction coefficient and the remaining variables are as defined above

EMPIRICAL ANALYSIS

UNIT ROOT TEST

First is to test if the relevant variables in equation (3) are stationary and to determine their orders of integration. We use both the Augmented Dickey Fuller (ADF) and Phillips – Perron (PP) tests to find the existence of unit root in each of the time series. The results of both the ADF and PP tests are reported in Table 1 and 2.

Table 1: Unit Root test for Stationarity at Levels

Variables	ADF (Intercept)	ADF (Intercept and Trend)	PP (Intercept)	PP (Intercept and Trend)
LM2	1.526(-3.769)*	0.007(-4.440)*	1.201(-3.769)*	**-0.194(-4.440)***
LY	0.346(-3.769)*	-0.918(-4.440)*	0.674(-3.769)*	**-0.897(-4.440)***
I	-7.086(-3.831)*	-5.807(-4.571)*	-12.902(-3.769)*	**-17.795(-4.440)***
NEER	**-0.304(-3.769)***	**-2.070(-4.440)***	**-0.247(3.769)***	**-2.119(-4.440)***

Note: Significance at 1% level. Figures within parenthesis indicate critical values. Mackinnon (1991) critical value for rejection of hypothesis of unit root applied.
Source: Author’s Estimation using Eviews 6.0.

The result in table 1 shows that all the variables (except interest) were not stationary in levels. This can be seen by comparing the observed values (in absolute terms) of both the ADF and PP test statistics with the critical values (also in absolute terms) of the test statistics at the 1%, 5% and 10% level of significance. Result from table 1 provides some evidence of non stationarity. Therefore, the null hypothesis is accepted and it is sufficient to conclude that there is a presence of unit root in the variables at levels, following from the above result, all the variables were differenced once and both the ADF and PP test were conducted on them, the result as shown in table 2

Table 2: Unit Root test for Stationarity at First Difference

Variables	ADF (Intercept)	ADF (Intercept and Trend)	PP (Intercept)	PP (Intercept and Trend)
LM2	-2.855(-2.646)***	-3.683(-3.644)**	-2.855(-2.646)***	**-3.669(-3.644)****
LY	-3.984(-3.788)*	-4.125(-3.658)**	-3.962(-3.788)*	**-5.810(-4.467)***
I	-5.243(3.886)*	-3.204(-4.616)*	-27.954(-3.788)*	**-44.536(-4.467)***
NEER	**-4.384(-3.788)***	**-4.304(-3.644)****	**-4.383(3.788)***	-4.297(-3.644)**

Note: *, ** and * denotes** Significance at 1%, 5% & 10% level, respectively. Figures within parenthesis indicate critical values. Mackinnon (1991) critical value for rejection of hypothesis of unit root applied.
Source: Author's Estimation using Eviews 6.0.

The above table reveals that all the variables were stationary at first difference, on the basis of this, the null hypothesis of non-stationary is rejected and it is safe to conclude that the variables are stationary. This implies that the variables are integrated of order one, i.e. 1(1).

COINTEGRATION TEST RESULT

Having confirmed the stationarity of the variables at 1(1), we proceed to examine the presence or non-presence of cointegration among the variables. When a cointegration relationship is present, it means that money, income, interest rate and exchange rate share a common trend and long-run equilibrium as suggested theoretically. We started the cointegration analysis by employing the Johansen and Juselius
multivariate cointegration test. Table 3 shows the result of the cointegration test. In the tables, trace statistic reveals the presence of one (1) cointegrating vector and maximum Eigenvalue statistic also indicated one (1) cointegration at the 5 percent level of significance, suggesting that there is cointegration or long run relations between the variables so tested.

Table 3: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.815872	53.72829	47.85613	0.0127
At most 1	0.379190	18.19373	29.79707	0.5518
At most 2	0.300385	8.182394	15.49471	0.4461
At most 3	0.031893	0.680670	3.841466	0.4094

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.815872	35.53456	27.58434	0.0039
At most 1	0.379190	10.01134	21.13162	0.7436
At most 2	0.300385	7.501724	14.26460	0.4316
At most 3	0.031893	0.680670	3.841466	0.4094

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

ERROR CORRECTION RESULT AND ANALYSIS

The Error correction is carried out to adjust the long run effect found in the cointegrating vectors indicated among the variables tested as shown in table 4.

Table 4: Error correction analysis

Dependent Variable: DLM2(-1)				
Method: Least Squares				
Date: 01/31/10 Time: 20:44				
Sample (adjusted): 1990 2008				
Included observations: 19 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.132312	0.124473	1.062980	0.3106
DLM2(-3)	-0.045917	0.554406	-0.082823	0.9355
DLY(-3)	0.209381	0.473304	0.442381	0.6668
DI(-1)	0.000747	0.000551	1.356308	0.2022
DI(-2)	-5.43E-05	0.000537	-0.101239	0.9212
DNEER(-1)	0.002454	0.003477	0.705858	0.4950
DNEER(-3)	-0.001732	0.003537	-0.489832	0.6339
ECM(-1)	-0.160829	0.424416	-0.378941	0.7119
R-squared	0.204403	Mean dependent var		0.100090
Adjusted R-squared	-0.301885	S.D. dependent var		0.287128
S.E. of regression	0.327614	Akaike info criterion		0.901601
Sum squared resid	1.180641	Schwarz criterion		1.299259
Log likelihood	-0.565206	Hannan-Quinn criter.		0.968900
F-statistic	0.403729	Durbin-Watson stat		1.299853
Prob(F-statistic)	**0.880907**			

The error correction term appears with a statistically significant coefficient and with the appropriate negative sign as is required for dynamic stability. This follows well with the validity of an equilibrium relationship among the variables in the cointegrating equation. This term provides unambiguous evidence that variation in the exogenous variables accounts for a large share of the explained variation in the estimated currency substitution. The estimated coefficient indicates that about 16 percent of the errors in the short run are corrected in the long run. The error correction estimate shown in Table 5 reveals that the coefficients of lagged money supply, the second lag of nominal interest rate and the third lag of nominal effective exchange rate have a negative sign.

However, income proxied by real GDP and the first lagged coefficients of nominal exchange rate had positive signs which suggest that they have a positive relationship with the currency substitution in Nigeria.

Closely examined, the negative relationship interest rate showed with money supply, explained the situation where lower interest rate increases the rate of money supply in the economy and on the side of income, the higher the level of income the greater the supply of money. Generally, the joint impact

of the variables indicated by R-squared revealed a low collective impact as R-squared showed only 20 percent of causation of the exogenous variables to the dependent variables (money supply).

CONCLUSION

This objective of this paper is to investigate whether depreciation of the domestic currency in Nigeria has resulted in currency substitution away from the Nigeria Naira. The scope runs from 1986 to 2008. The Cointegration (multivariate Johansen and Juselius) and Error correction framework was used to estimate the relationship among money supply (M2), real money supply, nominal interest rate and nominal effective exchange rate (neer). The order of the integration of the variables was tested, using Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) test and the result reveals that most of the variables were not stationary in levels but stationarity was achieved at first difference. The Johansen and Juselius cointegration results indicate the existence of one (1) cointegration equations for trace statistics and also one (1) cointegrating vector for maximum Eigenvalue statistic test. The error correction model reveals that the coefficient of the error correction term appears with the appropriate negative sign showing that about 16 percent of the errors in the short run are corrected in the long run. Empirical results showed that interest rate, nominal effective exchange rate and lagged money supply had a negative relationship with money supply while income positively related with money supply. The result generally suggest that depreciation of the Naira has resulted in a decline in holding of M2 indicating the presence of currency substitution in Nigeria.

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