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The Naira-Dollar Exchange Rate Determination: A Monetary Perspective

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Abstract

This paper applies the augmented Dickey-Fuller unit root and Johansen-Juselius cointegration methods to investigate whether the flexible price monetary model (FPMM) of exchange rate is consistent with the variability of the naira-dollar exchange rate from 1986-2002 (quarterly time series). The results show at least one cointegrating vector, suggesting a long-run equilibrium relationship between the naira-dollar exchange rate and the FPMM fundamentals.

Keywords: Naira-Dollar, exchange rate, flexible-price, monetary model, cointegration.
JEL Classification: F3

I. Introduction

During the period of 1970s, many developed (industrialized) countries adopted several floating exchange arrangements in order to stabilize their exchange rates. To this end, developing countries in sub-Saharan Africa, Asia, Latin America and others embarked on floating exchange rate regime, mainly in the 1980s. One such case is Nigeria – while experiencing economic distress in 1986, resorted to the structural adjustment program of which monetary policy and exchange rate determination were the main instruments of stabilization policy. Considering that the US is the major trading partner of Nigeria, it is significant to observe the exchange rate movements with respect to both nations' currencies; that is, the Nigerian Naira and the US Dollar. Thus, this study seeks to investigate the naira-dollar exchange rate determination within a monetary perspective.

Several research studies have been conducted as to whether the monetary approach to exchange rate determination is a viable model for exchange rate policy. Van den Berg and Jayanetti (1993) noted that most research studies during the 1970s were supportive of the monetary model. For example, Bilson (1976) successfully estimated the UK-German exchange rate by combining the assumption of PPP with the money-market equilibrium hypothesis, and incorporating dynamics into the model via the Bayesian estimation procedure. In addition, Frenkel (1976) postulated a model of the mark-dollar exchange rate during the German hyperinflation based on the assumption of PPP. He found that the model satisfied the goodness of fit and the signs and significant of the coefficients. Also, in support of the monetary approach, Edwards (1983) analyzed the Peruvian experience with floating exchange rates by employing a short-run version of the simple monetary model of exchange rate determination and found the results quite satisfactory. However, Humphrey and Lawler (1977), using the standard monetary model based on quarterly data, empirically investigated the behavior of the US-UK and US-Italy exchange rates, respectively. Their results show that the model does not represent an accurate description of the existing exchange rate regimes. In line with this thought, the econometric evidence postulated by Dornbusch (1980) leaves little doubt as to the unsatisfactory nature of the monetary model. He concluded that, not only does the short-term exchange rate deviate from a PPP path, but there are also cumulative deviations from that path that show substantial persistence. In the same vein, Pearce (1983) asserts that enough evidence exists to show that the PPP does not hold in the short run; hence, domestic and foreign bonds are not perfect substitutes as theorized by the monetary model.

Moreover, recent empirical studies using contemporary tests and techniques such as unit root and cointegration also found mixed results for the monetary model (Neely and Sarno 2002). For instance, Mcnown and Wallace (1989), and Baillie and Selover (1987) using cointegration found little or no evidence for the monetary approach to exchange rate determination. In sharp contrast, Rapach and Wohar (2004) lent support to the monetary model using panel procedures. In addition, Civcir (2003) applied the Johansen cointegration technique for the Turkish lira/U.S. dollar exchange rate to validate the monetary model, as in Francis et al (2001), Mcnown and Wallace (1994) and Van den Berg and Jayanetti (1993). Following these studies, this paper therefore proceeds to investigate the naira-dollar exchange rate determination within a monetary perspective from 1986-2002 by employing unit root test and cointegration because of the perceived nonstationarity of the time series variables.

The rest of the paper is as follows. Section 2 reviews the model and develops the testable (hypothesized) equation(s). Sections 3 and 4 present empirical (test) results and conclusions, respectively.

2. The Monetary Models of Exchange Rate Determination

As Rosenberg (1996) noted, there are many versions of monetary models of exchange rate determination all of which are outgrowths and extensions of the basic flexible-price model of Frenkel (1976) and Bilson (1978) as well as Dornbusch's (1976) sticky-price model, Frankel's (1979) real interest rate-differential model, and the Hooper-Morton (1982) equilibrium real exchange-rate model. Arbitrarily, the flexible price monetary model is chosen here for investigation.

2.1 The Flexible-Price Monetary Model

The flexible-price monetary model (FPMM) attempts to demonstrate how changes in the supply of and demand for money both directly and indirectly affect exchange rates. In line with Rosenberg, assume the following: a two-country global economy -- a domestic country (Nigeria) and a foreign country (USA); money supplies (m) in the two countries are exogenously determined by the respective central banks; real demand for money (m-p) is determined by the level of income (y) and the level of interest rate (i) and that their respective elasticities are the same in both countries. Following Sarno and Taylor in discrete time and utilizing time subscripts for emphasis, and asterisks to denote foreign variables and parameters, monetary equilibrium is achieved when the supply of and demand for money in each country are equalized as given by:

$$m_t = p_t + \beta y_t - \theta i_t \quad (1)$$

$$m^*_t = p^*_t + \beta^* y^*_t - \theta^* i^* t \quad (2)$$

Further, it is assumed that the domestic interest rate is predetermined in the world markets because of the implicit assumption of perfect capital mobility. In addition, assume that purchasing power parity (PPP) holds continuously:

$$e_t = p_t - p^*_t \quad (3)$$

Equating (1) and (2) would suggest the quantity theory of money which postulates that a country's price level is determined by the supply of money relative to the demand for money. Thus, if equations (1), (2), and (3) are combined, the result is the solution for the nominal exchange rate of the FPMM version:

$$e_t = \alpha\,(m - m^*)_t - \beta(y - y^*)_t + \theta(i - i^*)_t \quad (4)$$

where, α, β, θ are parameters.

Expectations could be introduced in equation (4) since the nominal interest rate consists of real interest rate and the expected inflation rate:

$$i_t = r_t + \pi^e_t \quad (5)$$

$$i^*_t = r_t^* + \pi^{e*}_t \quad (6)$$

where r_t and r_t^* are the domestic and foreign real interest rate and π^e_t and π^{e*}_t are the expected rates of domestic and foreign inflation, respectively. Supposing that real interest rates are equalized in both Nigeria and USA, then

$$i_t - i^*_t = \pi^e_t + \pi^{e*}_t \quad (7)$$

Thus, substituting equation (7) in equation (4) provides a more specified flexible-price monetary model (FPMM) of exchange rate determination in the form of:

$$e_t = \kappa + \alpha (m - m^*)_t - \beta(y - y^*)_t + \theta(\pi^e_t - \pi^{e*})_t + u_t \quad (8)$$

where κ is an arbitrary constant and u_t is a stochastic term.

Equation (8) implies that an increase in the domestic money supply relative to the foreign money stock induces a depreciation of the domestic currency relative to the foreign currency (a rise in e_t). Also, ceteris paribus, an increase in domestic real income, produces an excess domestic money demand. In order to increase their real money balances, spending by domestic residents decreases and prices fall until the market clears. Given the PPP, the fall in domestic prices assuming foreign prices constant, suggests an appreciation of the domestic currency relative to the foreign currency.

Lastly, according to equation (8), a relative rise in domestic interest rates which reflects an increase in domestic inflationary expectations, will lead to a depreciation of the domestic currency (a rise in e_t).

3. Unit Root Test for Nonstationarity

In line with Gujarati (1999), regression models involving time series data sometimes give results that are spurious, or of dubious value, in the sense that superficially the results look good but on further investigation they look suspect. This implies that the series might be nonstationary or contain unit root; a highly persistent time series process where the current value equals last period's value, plus a weakly dependent disturbance (Wooldridge 2006). Noting Greene (2003), the Augmented Dickey Fuller (ADF) test is employed to test for unit root based on an equation of the forms:

$$y_t = \mu + \gamma y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + u_t \quad (9)$$

$$y_t = \mu + \beta t + \gamma y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta y_{t-j} + u_t \quad (10)$$

where equations (9) and (10) indicate ADF tests without trend and with trend, respectively. Thus, the ADF unit root test posits a null hypothesis $\gamma = 0$ versus an alternative hypothesis $\gamma < 0$. As a result, implying that if the series have unit root, one can conclude that cointegration is necessary.

3.1 Cointegration

Since the cointegration test procedures of Johansen and Juselius (1990) can distinguish between the existence of one or more cointegrating vectors and also generate test statistics with exact distributions (Van den Berg and Jayanetti 1993); it is hereby appropriate to utilize. Thus, assuming a vector autoregressive (VAR) model:

$$\Delta x_t = \Sigma\Gamma_i \Delta x_{t-i} + \Omega x_{t-1} + \mu + \varepsilon_t \quad (11)$$

Where x_t is a vector of nonstationary variables p x 1 and ($i = 1,\ldots\ldots,k$).

In essence, the JJ (Johansen and Juselius) method tests whether the coefficient matrix Ω reflects the fundamentals of long run equilibrium among the non-stationary variables. As a result, if $0 < \text{rank}\ \Omega = r < p$, then there are matrices α and β of dimension p x r where $\Omega = \alpha\beta'$ and r cointegrating relations among elements of x_t; where α and β are cointegration vectors and error correction parameters, respectively.

3.2 Data and Empirical Test Results

First, all data variables were taken from the International Monetary Fund's (IMF) International Financial Statistics (IFS) CD-rom version based on quarterly series from 1986 to 2002. Second, unit root tests (see ADF unit root test: Table I) were performed on the time series variables of the naira-dollar exchange rate, the differences of the logarithms of national money supplies (M2), real income (Y), and expected inflation (CPI), respectively using the augmented Dickey-Fuller (1981) unit root test procedure. The results indicate that the unit root hypothesis cannot be rejected; hence, cointegration is required. Finally, the cointegration test (see Johansen-Juselius cointegration results: Table II) supports the FPMM of exchange rate. Specifically, the Trace and Eigenvalue tests were conducted, and each test finds at least one cointegrating vector at the 5 percent level; implying a long-run relationship between the naira exchange rate and the FPMM variables.

Table 1: Augmented Dickey-Fuller (ADF) test-Statistics for Unit Roots

Variable	t-Statistic	Probability*
Exchange Rate (e)	1.96	0.30
Money differential (m-m*)	0.12	0.94
Real income differential (y-y*)	1.21	0.66
Expected inflation differential (π^e_t-π^e*)	1.45	0.55

*Mackinnon (1996) one-sided p-values. The null of nonstationarity for the ADF critical values are –3.54, -2.91, and –2.59 for 1, 5, and 10 percent (%)levels of significance, respectively.

Table II: Johansen-Juselius Multivariate Cointegration Test Results

NH	TT	CV	NH	λMAX	CV
r = 0*	75.93	63.88	r = 0*	33.56	32.12
$r \leq 1$	42.37	42.91	$r \leq 1$	21.15	25.82
$r \leq 2$	21.22	25.87	$r \leq 2$	14.75	19.39
$r \leq 3$	6.47	12.52	$r \leq 3$	6.47	12.52

Notes: NH = Null hypothesis, TT = Trace test, CV = Critical values, r = number of cointegrating vectors in the system indicated by asterisk (*), λMAX = Maximum Eigenvalue test. The Critical values (CV) are at the 5 percent (%) level of significance. * denotes rejection of the hypothesis at the .05 or 5% level.

4. Conclusion

The time series on the naira-dollar exchange rate based on the ADF unit root tests and the Johansen-Juselius cointegration procedures show support (given one cointegrating vector) for the long run flexible-price monetary model of exchange rate in accordance with Frenkel (1976) and Bilson (1978).

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