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The Flex Price Monetary Model of the Dollar-Naira Exchange Rate Determination: A Cointegration Approach

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Abstract

This paper investigates the Nigerian naira and United States dollar exchange rates under Flex Price Monetary Model (FPMM) spanning time series of 1986-2008. The study applies Augmented Dickey-Fuller unit root test and Johansen Cointegration test to investigate the consistence of the FPMM with the variability of naira-dollar exchange rates operable in Nigeria since 1986. Main finding states that the Trace and Maximum Eigenvalue tests indicate at least one cointegrating vector at 5 percent (%) significant level therefore suggesting a long-run equilibrium relationship between the bilateral naira-dollar exchange rates vis-à-vis FPMM ethics therefore the results are in strong support of the Flex Price Monetary Model. This paper recommends establishment of Inflation Targeting Group (ITG) by the Central Bank of Nigeria (CBN) to take charge of targeting and forecasting inflation for Nigeria. Viable and consistent economic diversification policies in favour of flexible exchange rates should put in place with framework of trade expansion and diversion from over-reliance on petrodollars about 95% of Nigeria's foreign exchange earnings and about 85% of government revenue.

Keywords: Nigeria, US, Naira-Dollar, CBN, Flex Price Monetary Model, Cointegration.
JEL Classification Code: F31.

1. Introduction

Most of the Sub-Saharan African countries adopted flexible or floating exchange rate system as a result of the World Bank-International Monetary Fund's imported Structural Adjustment Programme (SAP) in 1986. SAP ushered in deregulation, stabilisation and liberalization of the Sub-Sahara African economies, Nigeria inclusive by embarking upon flexible exchange rate against the pre-SAP fixed, rigid or pegged exchange rate system with instrumentation of market forces to solve problems of market disequilibrium. Deregulation of exchange rate in Nigeria made an alignment with the floating monetary model operable in the developed countries in 1970s. Using a flexible monetary model, this study considers Nigeria's major trading partner, United States in determining her bilateral exchange rate of Nigerian naira and United States dollar for the period of 1986-2008. The period of 1960 to 1970 witnessed a fixed exchange rate of Nigerian ₦0.7143 per US$1.00 Dollar while in 1986 ₦2.0206 was exchanged per dollar at the inception of the World Bank-IMF imported SAP to Nigeria and other African countries (Alao, 2010b). In September 1986, Babangida regime introduced a transitory dual-carriage exchange rate system - first-tier and second-tier forex market later metamorphosed into the Foreign Exchange Market (FEM) in 1987 while Bureaux de Change was introduced in 1989 with a view to broaden the scope of the FEM. The flexible/floating Foreign Exchange Market (FEM) was to resolve problem of balance of payments, BOP deficits/disequilibrium which occasioned during fixed/rigid exchange rate era. Attempt of flexible Foreign Exchange Market (FEM) to produce unsatisfactory outcomes, Autonomous Foreign Exchange Market (AFEM) was introduced in order to further or partially deregulates Foreign Exchange Market to accommodate Central Bank of Nigeria (CBN) free discretionary intervention in free market network. AFEM metamorphosed into a daily, two-way quote Inter-bank Foreign Exchange Market (IFEM), October 25, 1999 while Dutch Action System (DAS) of two-way auction system was introduced on July 22, 2002 to allow CBN and authorized dealers to participate in forex market to buy and sell foreign exchange. According to CBN (2011), the introduction of Whole Sale Dutch Auction System (WDAS) on February 20, 2006, the liberalized Foreign Exchange Market witnessed unprecedented stability most of which include the following: (a) Unification of exchange rates between the official and inter-bank markets and resolution of the multiple currency problems and (b) Facilitation of greater market determination of exchange rates for the Naira vis-à-vis other currencies. A long list of studies has contributed to the exchange rates determination. An array of literatures can be viewed mostly in empirical perspective as stated in section two below. Building on the premises of the flexible price model, the 'sticky price', 'tradable-non-tradable' and net international reserves of Hooper and Morton (1982) monetary models were later developed on the basis of more realistic assumptions and to encompass more explanatory variables (Wong and Khan, 2006).

The objective of the paper is to examine and investigate the consistency of the flex monetary model with the variability of naira-dollar exchange rates operable in Nigeria since 1986. The remainder of this paper is organized as follows: Section two reviews the literature. Section 3 present data, preliminary diagnostics and empirical results while sections 4 and 5 present concluding remarks and recommendation respectively.

2. Literature Review

Concrete building blocks of exchange rate determination can be traced to the balance of payments (BoP) approaches – the elasticity of approach in 'The Foreign Exchanges' of Robinson (1937), Theory of International Economic Policy of Meade (1951), the theory of economic policy of Tinbergen (1952) and International Economics of Mundell (1968). Other groundwork of exchange rate determination is the pioneering study of Polak (1957) on the 'monetary approach to exchange rate determination' which was finetuned by Mundell (1968, 1971). Others include Johnson (1972, 1976, and 1977), Dornbusch (1976), Fry (1976), Frenkel (1976), Humphrey and Lawler (1977), Bilson (1978), Frankel (1979) and Mackinnon (1981), among others. Johnson (1972) examined 'The Monetary Approach to the Balance of Payments Theory', Johnson (1976) investigated 'Elasticity, Absorption, Keynesian Multiplier, Keynesian Policy and Monetary Approach to Devaluation Theory': A Simple Geometric Exposition' while Johnson (1977) also explored 'The monetary approach to the balance of payments: A nontechnical guide' of which his monetary approach uses monetary rather than multiplier and market stability tools. Bilson (1978) estimated the UK-German exchange rate by combining the assumption of PPP with the money-market equilibrium hypothesis while Fry (1976) studied 'A Purchasing-Power-Parity Application to Demand for Money in Afghanistan'. Dornbusch (1976) investigated sticky-price model, Frankel (1979) studied real interest rate-differential model while Mackinnon (1981) investigated 'Exchange Rate and Macroeconomic Policy: Changing Postwar Perceptions'. The Hooper-Morton's (1982) equilibrium real exchange-rate model is another approach to exchange rate determination. Frenkel (1976), based on the assumption of PPP, postulated a model of the mark-dollar exchange rate during the German hyperinflation while Humphrey and Lawler (1977), using the standard monetary model investigated the behaviour of the US-UK and US-Italy exchange rates, respectively. 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 supportive. However, McNown & Wallace (1989) and Baillie & Selover (1987) using cointegration found little or no evidence for the monetary approach to exchange rate determination. Rapach and Wohar (2004) contrarily support the monetary model using panel procedures while Jimoh (2004) investigated monetary approach to exchange rate determination: evidence from Nigeria with the model's support. Moreover, Civcir (2003) studied the Turkish Lira-U.S. dollar exchange rate to validate the monetary model, as in Francis, et al (2001) and Van den Berg and Jayanetti (1993). In the Nigeria context, Osagie (1985) and Ajayi (1988) using the structuralist approach in their study of external trade flow, contrasts the adoption of a more flexible exchange rate policy in Nigeria. Other studies on exchange rates determination include Agene (1991), Cookey (1997), Onuchuku and Tamuno (1997) and Ezirim and Muoghalu (2004) focuses on theoretical and empirically investigations on various aspects of crisis and volatility based on the Nigerian evidence. Studies and theorizing based on other LDCs also include the works of Kumari (1996); Obadan (2004); and Ndikumana and Boyce (2003) as well as Zortuk (2009)'s study on economic impact of tourism on Turkey's economy: Evidence from cointegration tests, and Islam and Hassan (2006)'s study on the monetary model of the Dollar-Yen exchange rate determination: A cointegration approach. Sarno and Taylor (2002) states that the standard macroeconomic models of exchange rate determination include flexible-price monetary model (FPMM), sticky price monetary model, equilibrium models and portfolio

balance model out of which the FPMM reign supreme especially for a deregulated economy like Nigeria since 1986. Moreover, Rosenberg (1996) also notes the 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's (1982) equilibrium real exchange-rate model. This study therefore joins the pool of the pro-FPMM for investigation with higher observations trend-up from 1986 to 2008 relative to Jimoh (2004) of 1987-2001 and Nwafor (2006) of 1986 to 2002. With regards to each country's structural/policy break, most studies on flexible monetary model cover deregulated era. The adoption of FPMM is justified due to the Nigeria structural break of 1986 which gave the pro-monetary model opportunity of spreading tentacles to the flex monetary model when flexible/floating exchange rate commenced where this paper also not in exclusive. Conclusively, a lot of supportive studies have examined the model under study but their coverage or observations are not elongated to 2008 in sharp contrast to this study which covers almost the deregulation years, 1986-2008.

The Flex Price Monetary Model (FPMM)

According to Frenkel (1979), Bilson (1978), Wong and Khan, (2006), Islam and Hassan (2006) and Nwafor (2006) 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. The flexible price monetary model defines the exchange rate as the relative prices of two monies (Nigerian Naira and US Dollar) and is determined by the interaction of market forces of the monies under study. Furthermore, relative prices in each country and exchange rates are related by the law of purchasing power parity, PPP which holds continuously. Assume a two-country global economy, a domestic country (Nigeria) and a foreign country (United States); the equilibrium is achieved when the supply and demand for money in each country are equalized. Following Nwafor (2006), Islam and Hassan (2006), the study starts with the following three equations:

(1) $et = pt - p^f t$ (purchasing power parity relationship)
(2) $mt = p_t + \beta y_t - \alpha i_t$
(3) $m^f t = p^f_t + \beta^f y^f - \alpha^f i^f_t$

Where: where (e) is the spot exchange rate that is units of domestic currency per unit of foreign currency), m and m^f are domestic and foreign money supplies exogenously determined by respective central banks, y and y^f are domestic and foreign real income and i and i^f are domestic and foreign short-term nominal interest rates.

Substituting equations (2) and (3) in equation (1) yields nominal exchange rate of the FPMM version:

(4) $et = \beta_1(m - m^f)_t - \beta_2(y - y^f)_t + \beta_3(i - i^f)_t + u_t$
where: f connotes foreign, β_1, β_2 and β_3 are parameters.

In econometric parlance, the FPMM to be estimated could be presented below

(5) $et = \beta_o + \beta_1(m - m^f)_t - \beta_2(y - y^f)_t + \beta_3(i - i^f)_t + u_t$

Invoking expected inflation to equation (5), the nominal interest rate consists of real interest rate and the expected inflation rate:

(6) $i_t = r_t + \pi^e_t$ (domestic nominal interest rate)
(7) $i^f_t = r^f_t + \pi^{ef}_t$ (foreign nominal interest rate)

where: rt and rt^f - are the domestic and foreign real interest rates
π^e_t and π^{ef}_t - are the expected rates of domestic and foreign inflation.

Equalizing real interest rates in Nigeria and US, then we have:

(8) $i_t - i^f_t = \pi^e_t + \pi^{ef}_t$

Taking (8) into (5) yields a more specified flexible-price monetary model of forex in form of:

(9) $e_t = \beta_0 + \beta_1(m_t - m^f_t) - \beta_2(y_t - y^f_t) + \beta_3(\pi^e_t - \pi^{ef}_t) + u_t$

where: e_t – exchange rate for period t
β_0 - arbitrary constant
m_t – money supply in a domestic country and its endogenously determined.
m^f_t - money supply in a foreign country and also exogenously determined.
π^e_t - domestic expected inflation rates
π^{ef}_t - foreign expected inflation rates
y - level of income (domestic)
y^f_t - level of income (foreign)
u_t - error term.

Equation (9) suggests that fundamentals such as the relative stocks of monies, relative output levels and expected inflation differentials in the bilateral exchange relation have an impact on the spot exchange rates. As it is, although the model does not specify how expectations are formed, the general academic consensus is that the model holds in the context of rational expectations (De Grauwe 2000) therefore adopting equation (9) for this study is in fellowship with Frenkel (1976), Bilson (1978), Nwafor (2006), Islam and Hassan (2006) and Zortuk (2009).

3. Data, Preliminary Diagnostics and Empirical Results

This section presents the empirical results from the Eviews 5.0 Version of statistical software package. All data variables were obtained from on-line World Bank (2010)'s Data Base of the World Development Indicators (WDI) and Global Development Finance (GDF) and the Central Bank of Nigeria Statistical Bulletin (Golden Jubilee Edition, 1960-2008) based on annual time series of 1986-2008. The Nigeria-US time series variables include the naira-dollar exchange rates (e), the differences of the

logarithms of national monies (M2), expected inflation (π^e) differential (CPI in percentage), and real money income (y) differential (income receipts, BoP).

Descriptive statistics of variables are presented in Table1 where variables depict relatively low variability. From table 1, minimum naira-dollar exchange rate is ₦2 while ₦134 is the maximum as average (mean) exchange rate is ₦60. Inflation differential, as reported by table 1 gives 20, 11, 70 and 2 as mean, median, maximum and minimum statistics respectively while money supply and income differentials depict negativity for mean, median, maximum and minimum values. Tables 2 and 3 contain covariance and correlation matrices.

Table 1: Descriptive Statistics of Variables (1986-2008)

	LNe	$LN\pi^{enig}-\pi^{eus}$	$LNm^{nig}-m^{us}$	$LNy^{nig}-y^{us}$
Mean	60.02007	20.3796%	-6447841.	-302482.1
Median	21.88610	11.3000%	-4982928.	-256561.7
Maximum	133.5004	70.0000%	-3495230.	-97007.57
Minimum	2.020600	2.1100%	-36749005	-816369.7
Std. Dev.	54.45080	21.0182%	6695522.	207678.6
Skewness	0.295532	1.0801	-4.282818	-1.340189
Kurtosis	1.217738	2.674579	19.94285	3.708357
Jarque-Bera	3.378904	4.573858	345.4123	7.365942
Probability	0.184621	0.101578	0.000000	0.025148
Sum	1380.462	468.7300	-1.48E+08	-6957087.
Sum Sq. Dev.	65227.56	9718.848	9.86E+14	9.49E+11
Observations	23	23	23	23

Source: Computed from data

Covariance matrix measures the linear relationship between random variables. It indicates how much two variables intertwine or change together. Positive covariance indicates that higher than average values of one variable tend to be paired with higher than average values of the other variable and vice versa (Ram and Prabhakar, 2010). Table 2 clearly indicates that the values in the covariance matrix are positive and negative and therefore clear that these variables are directly and inversely related.

Table 2: Covariance Statistics

	LNe	$LN\pi^{enig}-\pi^{eus}$	$LNm^{nig}-m^{us}$	$LNy^{nig}-y^{us}$
LNe	2835.98	-477.93	32702175.42	-8479056.8
$LN\pi^{enig}-\pi^{eus}$	-477.93	422.56	29070891.27	1732025.1
$LNm^{nig}-m^{us}$	32702175.42	29070891.27	42880880803596	-172118159010
$LNy^{nig}-y^{us}$	-8479056.8	1732025.1	-172118159010	41255169156.9

Source: Computed from data

The correlation matrix of Table 3 presents preliminary information of the relationship between the variables under investigation. The study finds that the correlations are mixed - positive and negative. The highest contemporaneous correlations are shown between y^{nig}-y^{us} and π^{enig}-π^{eus} variables while the lowest are shown for the y^{nig}-y^{us} and e variables. Inflation rate differential is negatively related with exchange rate while money supply differential is positively related with exchange rate and inflation differential. Income differential is inversely related with exchange rate, positively related with inflation differential and negatively related with money supply differential.

Table 3: Correlation matrix

	LNe	$LN\pi^{enig}$-π^{eus}	LNm^{nig}-m^{us}	LNy^{nig}-y^{us}
LNe	1.00			
$LN\pi^{enig}$-π^{eus}	-0.44	1.00		
LNm^{nig}-m^{us}	0.09	0.22	1.00	
LNy^{nig}-y^{us}	-0.78	0.41	-0.13	1.00

Source: Computed from data

Time Series Properties: Unit Root Results and Cointegration Test
Testing for cointegration is in two phases:

a. Unit Root Test

The first phase is to determine whether the variables under study are stationary or not. If a series is non-stationary, then all the usual regression results suffer from spurious regression (Granger and Newbold, 1977; Gujarati, 1999). The study incorporates the Augmented Dickey Fuller, ADF (1979, 1981) test and performed both on the levels and the first differences of the variables (see Table 4). The first or second differenced terms of most variables will usually be stationary (Ramanathan, 1992). From Table 4, ADF test indicates that (e) and (π^{enig}-π^{eus}) are integrated of order one, I(1). The other two variables are stationary at levels, I(0).

Table 4: Augmented Dickey Fuller Unit Root Test

Variable	**ADF t-statistic**	**Critical Value**	**Order of Integration**
LNe	-3.9710	-3.7880	I(1)***
$LN\pi^{enig}$-π^{efus}	-5.5194	-3.8085	I(1)***
LNm^{nig}-m^{fus}	-5.05	-3.7695	I(0)***
LNy^{nig}-y^{fus}	-8.49	-3.7695	I(0)***

Source: Compiled by author
Notes: * Significant at 10 percent.
** Significant at 5 percent.
*** Significant at 1 percent.

b. Cointegration Test

In **the second phase,** cointegration test is performed to showcase the existence of a long-run relationship of the variables. Van den Berg and Jayanetti (1993) maintained

that, since the cointegration test procedures of Johansen and Juselius (1990) can distinguish between the existences of one or more cointegrating vectors and also generate test statistics with exact distributions. The Johansen cointegration results of Table 5 support the FPMM of exchange rate. The Trace and Eigenvalue tests show at least one cointegrating vector each at 5 percent level. The results imply a long-run relationship between the naira exchange rate and the FPMM variables.

Table 5: Johansen Cointegration Test Results (Period: 1986-2008)

Null Hypothesis	**Trace Tests**	**λMax-Eigenvalue**	**Critical Values (95%) TT**	**Critical Values (95%) MAX**
r = 0*	137.03	108.19	47.86	27.58
r ≤ 1	28.85	20.28	29.80	21.13
r ≤ 2	8.57	8.54	15.49	14.26
r ≤ 3	0.02	0.02	3.84	3.84
Parameter Estimates (Normalized)			**Cointegrating Vector**	
Variables				
LNe			1.0000	
$LN\pi^{enig}-\pi^{eus}$			-0.8957	
$LNm^{nig}-m^{us}$			0.000005	
$LNy^{nig}-y^{us}$			0.0003	

Notes: r = stands for the number of cointegrating vectors in the system indicated by asterisk, *. The Critical Values are at 0.05 or 5% percent significant level. Asterisk (*) denotes rejection of the hypothesis at the 0.05 or 5 percent (%) level.

The normalized cointegrating coefficients are shown in the last row of Table 5, and the signs of the variables confirm to the theory in the literature that is there are positive and negative relationship between variables.

4. Concluding Remarks

This study explores the bilateral Naira-Dollar exchange rate determination under Flexible Price Monetary Model (FPMM) covering the period of 1986-2008. The paper applies Augmented Dickey-Fuller unit root test and Johansen Cointegration test to investigate the consistence of FPMM with the variability of the naira-dollar exchange rates. The Johansen cointegration procedures corroborates previous studies by identifying cointegrating vector for long-run relationship between bilateral naira-dollar exchange rates and proximate determinants of the monetary model in accordance with Frenkel (1976), Bilson (1978), Nwafor (2006), Islam and Hassan (2006) and Zortuk (2009).

5. Recommendation

On the basis of this study, the following recommendations are made:

a. Inflation is an economic indicator that eats deep into the fabrics of (most) emerging/developing economies. The higher the inflation, the worse the economy and vice versa. Government or central bank should therefore promote policy transparency; transparency of which to lower inflationary expectations and reduce inflation differential relative to developed countries. This paper therefore recommends an establishment of Inflation Targeting Group (ITG) by

the Central Bank of Nigeria, CBN to take charge of targeting and forecasting inflation for Nigeria.

b. Viable and consistent economic diversification policies in favour of flexible exchange rates are recommended and should put in place with framework of trade expansion and diversion from over-reliance on petrodollars about 95% of Nigeria's foreign exchange earnings and about 85% of federal revenue.
c. The Standard Organization of Nigeria (SON) in conjunction with the Association of Nigerian Exporters (ANE) must be overhauled and empowered to ascertain good quality of Nigerian products and collectively search for more foreign markets to enhance favourable and better balance of payment (BoP) as spelt by Mundell-Fleming Model's flexible exchange rate.
d. Besides United States, ANE should work to see whether higher forex earnings can be obtained from other developed world like United Kingdom, Japan, France, Germany, China, and so on or group of them (basket of currencies) in order to achieve better terms of trade in their markets and exploit their potentials in penetrating foreign markets for better tradable goods.

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