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ABSTRACT

We test whether the flexible price monetary model (FPMM) of exchange rate determination is consistent with the variability of the naira-dollar exchange rates. The study account for several important issues overlooked by previous studies on the validity of FPMM including the test of long-run PPP relationship-a major building block of the monetary model, the issue inefficient estimation of cointegrating parameters, and the inconsistency of these parameters with the values implied by the monetary models. The test of long-run PPP relationship indicates that exchange rate and relative prices will apparently drift apart without bounds in the long-run, implying a failure of the long-run PPP proposition. This indicates grounds for believing the pure monetary model and its simple extensions to be misspecified as a long-run relationship and consequently suggests that it is inappropriate for forecasting purposes. We suggest a multinational model of exchange rate determination that allow for common macroeconomic effects.

Key words: Flexible Price, Monetary Model, naira-dollar, exchange rate, dynamic OLS

INTRODUCTION

The Bretton Woods monetary system of fixed exchange rates, which evolved immediately after World War 11, worked fairly well for about thirty years until it broke down in 1973. Upon the demise of the Bretton Woods system, a generalized system of floating exchange rates emerged, particularly for the developed countries to help stabilize their exchange rates. Following the World Bank-International Monetary Fund's designed structural Adjustment Programme (SAP) in the late 1980s, many Sub-Sahara African countries adopted flexible or floating exchange rate system. SAP, which was adopted in 1986 in Nigeria, ushered in deregulation and liberalization of exchange rate against the pre-SAP fixed exchange rate system with instrumentation of market forces to solve the problems of market disequilibrium. Considering the United States (Nigeria's major trading partner), this study investigates the econometric validity of the Flexible Price Monetary Model (FPMM) of exchange rate determination that is widely used in forecasting nominal exchange rate movements under the modern float system. In other words, the study tries to find out if the FPMM is consistent with the variability of the naira-dollar exchange rates over the deregulation era (1986-2010).

The standard monetary model of exchange rate determination assumes that the fundamentals of money supply and demand (relative money supply, real money income, interest rate, prices and expected inflation) drive the exchange rate through the purchasing power parity, PPP, relationship. Its basic premise is that any balance of payments disequilibrium or exchange rate movement result from monetary disequilibrium- that is, differences between money demand and money supply. Thus, the monetary approach emphasizes the determinants of money demand and money supply. If the exchange rate is fixed, the monetary approach pertains to the balance of payments wherein it is called the monetary approach to balance of payments (MABP). In contrast, the monetary model which explains exchange rate movement under a floating regime is known as the monetary approach to exchange rates (MAER). Prior to MAER, it was common to emphasize international trade flows as the primary determinant of exchange rates movement. In this context, countries with current trade surpluses were expected to have appreciating currencies, while those with trade deficit should have depreciating currencies. But the world does not work in this simple way. There are instances when countries with trade deficits have appreciating currencies and those with trade surpluses have depreciating currencies. Thus, the MAER provides an alternative view of the BOPs disequilibria and exchange rate movements. Its clear-cut intuition – that a country's price level is determined by its supply and demand for money and that the price level in different countries should be the same when expressed in the same currency, (Rapach and Wohar, 2004: 360)- makes it an attractive theoretical tool for understanding fluctuations in exchange rates over time. Despite the theoretical appeal of the monetary models, several empirical studies point to its dismal forecast performance under the modern float system. For instance, Meese and Rogoff (1983) find that the naïve random walk model outperforms an array of structural models, including those based on monetary fundamentals in predicting U.S. dollar exchange rate. A number of other studies also find no evidence of cointegration among nominal exchange rates and monetary fundamentals during the post-Bretton Woods float; see, for example Sarantis (1994), Baillie and Selover (1987), McNown and Wallace (1989), and Baillie and Pecchenino (1991). It is now recognized that exchange rates are difficult to track and exchange rate models are characterized by parameter instability and dismal forecast performance. According to Najand and Bond (2000:15), exchange rate models developed over the last two decades proved unreliable and unstable when presented with different data sets compared to naïve models such as a random walk. Given the poor performance of monetary models of exchange rate, this study seeks to investigate how well the FPMM of naira-dollar exchange rate determination conforms to the deregulation data (float regime). We take Nigeria as the domestic economy and begin by providing the most extensive empirical evidence to date on the performance of the monetary model for exchange rate determination.

The balance of the paper is organized as follows. Section 2 presents an eclectic review of several empirical studies that provide evidence of the performance of monetary models of exchange rate determination. Section 3 provide a critical overview of the theoretical issues and fundamental assumptions underlying the flexible price monetary model (FPMM) that is widely employed by most countries (under the modern float system) in predicting exchange rate movements. Section 4 reports our test results for the long-run monetary model, including the unit root, cointegration, cointegrating coefficient estimates and test of long-run PPP relationship. The paper is concluded in section 5.

Eclectic review of empirical literature: While some studies have found empirical evidence in support of long-run relationship between nominal exchange rates and the basic monetary fundamentals, others provide evidence that point to its dismal failure. The studies that are supportive of the monetary models of exchange rate determination include Johnson (1972, 1976 and 1977), Dornbush (1976), Fry (1976), Frenkel (1976), Humphrey and Lawler (1977), Bilson (1976, 1978), Van den Berg and Jayanetti (1993), Mcnown and Wallace (1994), Francis et al (2001), Frankel (1979), Civcir (2003), Rapach and Wohar (2002), Nwafor (2006) and Alao et al (2011). Bilson (1976), for instance, successfully estimated the UK-German exchange rate by combining the assumption of purchasing power parity (PPP) with the money market equilibrium hypothesis and by bringing in dynamics into the system through the Bayesian estimation procedure. Frenkel (1976) postulated a testable 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, the signs and the significance of the coefficients. Edward (1983) employed the short-run version of the simple monetary model of exchange rate determination to analyzed the Peruvian experience and found the result to be supportive of the monetary approach. Civcir (2003) applied the Johansen cointegration technique for the Turkish lira/U.S. dollar exchange rate to validate the monetary model. McNown and Wallace (1994) whose earlier work in 1989 casts severe doubts on the applicability of the monetary model re-estimated their model in 1994 and employed Johansen's (1990) technique to test for a cointegration relationship. Their findings indicate that although the long-run relationship among the variables of the monetary model is robust for alternative variable definitions, the estimated parameter values and signs are sensitive to model specification. In Nigeria, studies by Nwafor (2006) and Alao et al. (2011) employ Johansen and Juselius (1990) tests for cointegration and found the nominal naira-dollar exchange rate to be cointegrated with basic monetary fundamentals, namely, relative money supply, relative money income and relative expected inflation. Regrettably, it is difficult to say whether their results are supportive of the monetary model as they failed to provide estimates of the cointegrating parameters and yet, for the estimates to be supportive of the monetary model, the estimated coefficients must be consistent with the model in terms of the magnitudes and signs predicted by the monetary models (Cushman, 2000: 593).

On the other hand, studies by Humphrey and Lawler (1977), Mcnown and Wallace (1989a), Ballie and Selover (1987), (Neely and Sarno, 2002), Pearce (1983), Cushman (2000) and Rapach & Wohar (2004) found little or no evidence in support of the monetary model. Rapach & Wohar (2004: 868) note that even studies that find evidence of cointegration between nominal exchange rates and monetary fundamentals under the modern float lend little support to the values predicted by the monetary models. Using Johansen (1991) and Augmented Engle Granger (1987, AEG) test for cointegration, Rapach & Wohar (2004) obtained cointegrating coefficient estimates that are inconsistent with the monetary model on a country-by-country basis. Even when they employ panel data test procedure, their results show that the homogeneity assumption concerning the cointegration coefficient (which is needed to find support for the monetary model) was not supported by the data in that formal test of the homogeneity restrictions were rejected. On the basis of this, Rapach & Wohar (2004: 893) conclude that the support for the monetary model provided by the panel procedure is spurious. As we see in Pearce (1983), there are evidences 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 (see section 3.1). Cushman (2000) finds evidence of cointegration between the US dollar-Canadian dollar exchange rate and a set of monetary fundamentals over the modern float, but that the estimated cointegrating coefficients differ widely from those predicted by the monetary model. Cushman (2000:593, 601) therefore concludes that there is no support for the monetary model in US-Canadian data. According to Cushman (2000: 598), it is now recognized that for support of monetary exchange rate model, the estimated vectors and coefficients should be consistent with the model. Baillie and selover (1987) test the econometric validity of the FPMM of exchange rate for Canada, France, Japan, United Kingdom and West Germany vis-à-vis the US dollar using the cointegration technique of Engle and Granger (1987) which unlike Johansen's (1990) does not allow for the existence of more than one cointegrating vectors. Their results provide more dismal evidence on the inappropriateness of the monetary model. They conclude that attempts at using the monetary models to forecast will generally not be worthwhile and results such as those obtained by Meese and Rogoff (1983) are entirely to be expected. The lack of empirical evidence for a stable long-run relationship among nominal exchange rates and monetary fundamentals renders the monetary model a seemingly plausible theoretical model with little practical relevance. Baillie and Selover (1987:44), thus, suggest that it is more appropriate to consider multinational models of exchange rate determination to allow for common macroeconomic effects, that is, to capture the influence of economic magnitudes that are common to countries. They employed a Seemingly Unrelated Regression Equation (SURE) system with a first order vector autoregressive (VAR) error process to capture such inter-country effects. This idea have been acknowledged in related, but different exchange rate studies by Edward (1983) and Hakkio (1984) who use the fact that change in level of one exchange rate will be useful information in predicting the level of other exchange rates. We consider the multinational models to be more viable for predicting exchange rate movements especially among countries with synchronous or symmetric inter-country influences/shocks (Ekong & Onye, 2012). As earlier noted, Meese and Rogoff (1983) found that a naïve random walk model outperforms an array of structural models, including those based on monetary fundamentals, in predicting U.S. dollar exchange rates at horizons of up to 12 months during the late 1970s and early 1980s. This does not mean, however, that monetary factors are of no importance in predicting exchange rate movement but that the monetary model may have been misspecified. Mark (1995) rekindled hope for the monetary model by showing that deviations from a simple set of monetary fundamentals-money supply, real money income, interest rate and inflation differentials-are useful in predicting U.S. dollar exchange rate at longer horizons over the 1981-1991. But it is remarkable to note that evidence for exchange rate predictability in Mark (1995) hinges critically on the assumption of a stable cointegrating relationship between nominal exchange rate and monetary fundamentals. Such evidence diminishes when this assumption is relaxed (see Berben, 1995; van Dijk, 1998; Berkowitz and Giorgianni, 2001) and, in fact, Mark (1995) fails to find evidence of cointegrating relationship. It has been argued that the failure to find cointegrating relation in much of the extant literature results from failure of long-run PPP (which posits a long-run stable relationship between exchange rate and relative prices) and short span of data typically employed, which cover only the post-Bretton Woods float. The argument is that, because standard tests take no cointegration as the null hypothesis and the power to reject the null is extremely low when short span of data are employed, the null of no cointegration are often accepted than justified by the data. It does not help that the data are often sampled at monthly or quarterly frequencies, as the power of unit root and cointegration tests depends on the data's span, rather than its frequency (Shiller and Perron, 1995; Hakkio and Rush, 1991). Two responses to the problem of low power, namely, the use of panel test procedure and the use of long span of data appear in PPP literature. Panel studies by Frankel and Rose (1996), Oh (1996), Wu (1996), Papell (1997), Taylor and Sarno (1998), Groen (2000), and Mark and Sul (2001) find support for the long-run PPP for the post-Bretton Woods era but it is anti-climactic to pursue such panel test procedure today. This is because, as earlier noted, it is difficult to find empirical support for the homogeneity restriction on the parameter even where such parameters are cointegrating (see Rapach and Wohar, 2004: 869). In other words, it is not always the case that the pre-specified values for the homogenous cointegrating coefficients, as in Mark and Sul (2001), are supported by the data. Again, even if it is accepted that short span of data create problem of low power, there are no convincing evidences to show that long span of data do not increase the power to reject the null of no conintegration which would imply accepting the alternative hypothesis of a cointegrating relationship far more often than actually justified by the data.

The ultimate objective of our evaluation is to assess just how well the monetary model (FPMM) of naira-dollar exchange rate determination conforms to the deregulation data (float era). In order to find support for the monetary model, we require two pieces of evidence: (i) we need to obtain estimates of the cointegrating coefficients relating the nominal exchange rate to a set of monetary fundamental that agree with the values predicted by the monetary model; (ii) we need to find evidence that the nominal exchange rate is in fact cointegrated with the monetary fundamentals. As earlier noted, the finding by Nwafor (2006) and Alao et al (2011) that the naira-dollar exchange rates is cointegrated with monetary fundamentals do not necessarily validate the monetary model as they failed to provide estimate of the cointegrating coefficients. For support of a particular model such as the monetary model, the estimated vectors and coefficients should be consistent with the model (Cushman 2000:593,598; Rapach and Wohar 2004). We first reconsider the theoretical issues and basic assumptions of the monetary model and their implications for the naira-dollar exchange rate determination.

Theoretical issues on monetary exchange rate model: Much of the recent work on floating exchange rates determination goes under the name of the "monetary" or "asset" view in which the exchange rate is perceived as moving to equilibrate the international demand for stocks of assets, rather than the international demand for the flow of goods, as it were, under the more traditional view (Frankel, 1979). Within the monetary perspective, however, there are two different approaches which have conflicting implication in particular for the relationship between exchange rate and interest rate.

The first approach, which is known as "Chicago" theory assume secular prices, that is, that prices are perfectly flexible. As a consequence of this assumption of secular prices, nominal interest rates reflect or represent changes in **expected inflation** rates. This means that domestic nominal interest rate rises (relative to foreign nominal interest rate) when domestic inflation rate is **expected** to rise. As domestic interest rate rises, the demand for domestic currency falls relative to the demand for foreign currency, given stable money demand function, [$M^d = f(p, y, i)$]. The fall in demand for domestic currency leads to rise in exchange rate (depreciation of the domestic currency) as more of the domestic currency now exchanges the same unit of the foreign currency. Thus, from the Chicago theory, we get a positive relationship between exchange rate and interest rate. How plausible are these assumptions for naira-dollar exchange rate determination? First, the issue of instability of money demand is, no doubt, one of the most inconclusive and recurring issues in the theory and application of macroeconomic policy. Second, a more perceptive view shows that the demand for foreign exchange is not in any way related to interest rates as government demand bulk of the forex due to the weak private sector (but accommodating informal sector) in a crawling economy like Nigeria. The second approach is called the "Keynesian" theory because it assumes that prices are sticky, at least in the short run. As fallout of the sticky price assumption, changes in nominal interest rate reflect changes in tightness of monetary policy. This means that domestic nominal interest rate rises relative to foreign nominal interest rate due to contraction in domestic money supply. Given sticky prices, as domestic nominal interest rate rises, capital inflows are attracted into the domestic economy which causes the demand for domestic currency to increase. The increase in demand for domestic currency leads to fall in exchange rate (appreciation of the domestic currency). This gives a negative relation between exchange rate and nominal interest rate. As we see in Frankel (1979), the Chicago theory is a realistic description when variation in inflation differential is large, as in the German hyperinflation of the 1920s to which Frenkel (1976) first applied it while the Keynesian theory is appropriate when variation in inflation differential is small, as in the Canadian float against the United States in the 1950s to which Mundell (1964) first applied.

By combining the Keynesian assumption of sticky prices with the Chicago assumption that there are secular (flexible) rates of inflation, Frankel (1979) developed a testable monetary model of exchange rate determination in which the spot exchange rate, e (unit of domestic currency per unit of foreign currency, say, N/$) is expressed as a function of money supply differential, money income differential, expected long-run inflation differential and nominal interest rate differential. His monetary model of exchange rate determination is reproduced here as follows:

$$e = m - m^* - \phi(y - y^*) + \alpha(i - i^*) + \beta(\Pi - \Pi^*) + u \text{ ------(2.1)}$$

where * connotes foreign, m =domestic money supply; m* = foreign money supply; m - m* = money supply differential; y= domestic money income; y*=foreign money income, i=domestic nominal interest rate; i*=foreign nominal interest rate, Π=domestic expected inflation rate; Π*=foreign expected inflation rate; Π-Π*=expected inflation differential.

3.1 The Flexible-Price Monetary Model (FPMM)

The popular models of exchange rate determination that are widely used in forecasting nominal exchange rates under the modern float system include the pure flexible price monetary model of Frenkel (1976) and Bilson (1978), the sticky price monetary model of Dornbusch (1976) and the real interest rate differential model of Frankel (1979). As we see in Rosenberg (1996), all other monetary models are offshoots and mere extensions of these basic models. The pure flexible-price monetary model (FPMM) shows how the supply of and demand for money both directly and indirectly affect exchange rates. Relative prices in each country and exchange rates are related by the law of purchasing power parity (PPP) which is assumed to hold continuously in the short and long-run. Assume a two-country global economy; equilibrium in the naira-dollar exchange rates is achieved when the supply of and demand for naira and dollar in each country are equalized. Following Frenkel (1976) and Bilson (1978), the FPMM starts with the following three equations:

$e_t = p_t - p^f_t$ ------------(2.2): purchasing power parity relationship

$m_t = p_t + \beta y_t - \alpha i_t$ --------------------------(2.3):domestic money supply equation (Nigeria)

$m^f_t = p^f_t + \beta^f y^f_t - \alpha^f i^f_t$ ----------------------(2.4): foreign money supply equation (U.S)

where e is the spot exchange rate, m_t and m^f_t are domestic and foreign money supplies respectively at time t, i_t and i^f_t are the respective domestic and foreign short-term nominal interest rates while α and β are coefficients.

The long-run PPP relation (2.2), a major building block of the monetary model, assumes that PPP hold continuously, even in the long-run, while 2.3 and 2.4 assume stable money demand functions in both countries. Basically, there are two views on the validity of PPP relationship. One view is that it holds strictly, even in the short-run because international reserves flow quickly in response to new events and prices adjust quickly to new equilibrium levels. This fast adjustment is supposedly due to the belief that financial assets in the domestic and foreign economies are perfectly substitutable. Obviously, this abstraction is highly implausible, especially in a crawling economy like Nigeria's with u*nderdevelope*d financial system. As earlier noted**,** Pearce (1983) provides evidence to show that the PPP does not hold even in the short run; hence, domestic and foreign bonds are not perfect substitutes as theorized by the monetary model**.** The second view also assumes that PPP also holds, but only in the long run because prices adjust slowly. This view emphasizes the role of goods market, rather than financial market, in international adjustments. The idea is that since goods prices are supposedly slow to adjust, short-run deviations from PPP will occur that gives rise to balance of trade effect. But the truth of the matter most likely lies between these two extremes. It is reasonable to expect goods prices to adjust slowly over time to changing economic conditions; so it may be reasonable to doubt that PPP holds strictly in the short-run. To ignore international capital flows is to miss the potentials for a faster adjustment than is possible strictly through the goods market.

By substituting equation 2.3 and 2.4 into 2.2, we have a nominal spot exchange rate of the FPMM version as follows:

$$e_t = £(m-m^f)_t - \beta(y-y^f)_t + \alpha(i-i^f)_t + ut \text{ -- ------- (2.5)}$$

Where f denotes foreign while £, β and α are parameters.

Since the nominal interest rate (i_t) consists of real interest rate (r_t) and expected inflation rate ($\boldsymbol{\Pi^e_t}$), we can introduce expectation into equation 2.5 as follows;

that is, given that $i_t = r_t + \Pi^e_t$ -------------------------(2.6)

and $i^f_t = r^f_t + \Pi^{ef}_t$ -------------------------(2.7) where i and r are nominal and real interest rates respectively,

we substitute 2.6 and 2.7 in 2.5 to have;

$e_t = £(m-m^f)_t - \beta(y-y^f)_t + \alpha(r-r^f)_t + \alpha(\Pi^e_t - \Pi^{ef}_t)_t + u_t$ --(2.8)

if expectations and uncovered interest parity are assumed, as in the Dornbusch (1976) sticky price model, the real interest differential ($r_t - r^f_t$) drops out since α in equation 2.8 becomes zero (see Baillie and Selover 1987:44; Bilson 1978; MacDonald 1979). This gives us the pure flexible monetary model of the forex as follows:

$e_t = \Omega + £(m-m^f)_t - \beta(y-y^f)_t + \alpha(\Pi^e_t - \Pi^{ef}_t)$ ------------(2.9)

where e_t = exchange rate at period t; Ω = arbitrary constant; $m-m^f$ =money supply differential; $y-y^f$ = real money income differential; $\Pi^e_t - \Pi^{ef}_t$ = expected inflation differential; £, β, α = parameters; and u_t = error term.

The a priori expectations about the signs of the coefficient are as follows:
$£ > 0$, $\beta < 0$, $\alpha > 0$ (see Frankel 1979; Frenkel 1976).

Equation 2.9 is the monetary model (FPMM) which is the relevant one for the long-run equilibrium (measured by cointegration) that is widely applied in forecasting exchange rate movement under the modern float system.

The FPMM thus clearly abstracts from (assume away) imperfect substitutability between the assets of the two countries, which may lead to coefficients that differ from those implied by the components of the monetary model (McNown and Wallace 1994; Girton and Roper 1977). Similarly, Alogoskoufis and Smith (1991) emphasize that the coefficients of a long-run equation, such as 2.9 can be a combination of adjustment, expectation, and structural parameters. Thus, the coefficients in the FPMM may not accurately reflect the driving force behind nominal exchange rate movements, cannot be given structural interpretation, and may be expected to depart from the values implied by the above derivation of the monetary model (Dickey, Jansen and Thornton 1991). Although the FPMM does not specify that expectations are formed, the general academic consensus is that the model holds in the context of rational expectations (De Grauwe, 2000). In fellowship with Frenkel (1976), Frankel (1979), Bilson (1978), Nwafor (2006), Zortuk (2009), we test for cointegration of nominal naira-dollar exchange rate with the monetary fundamentals in equation 2.9 (see section 4.2.2)

Data and empirical results: This section presents the empirical result estimated with the aid of the quantitative econometrics software, EViews 7.0. For clarity, the data, preliminary diagnostic results and the empirical results are distinctly presented and discussed. We rely on the Augmented Dickey-Fuller (ADF), Phillips Perron (PP) and Kwaiatkowski-Phillips-Schmidt-Shin (KPSS) for the test of nonstationarity in the series while utilizing Johansen's (1991) maximum likelihood and Phillips and Ouliaris (1990) tests for a cointegration of nominal naira-dollar exchange rate with the monetary fundamentals. The cointegrating coefficients are estimated using Phillips and Hansen's (1992) fully-modified OLS (FM-OLS) and Stock and Watson's (1993) dynamic OLS (DOLS). The choice of FM-OLS and DOLS over Static OLS (SOLS) is due mainly to the fact that the coefficients £, β, and α in (2.9), for instance, are inefficient because they suffer from asymptotic bias unless the regressors are strictly exogenous (Rapach and Wohar 2004: 872; Hamilton 1994; Rapach and Wohar 2002: 364; EViews 7.0, p. 221).

The data: Annual time series on naira-dollar official exchange rate, M2-money supply (in % of GDP), real money income (income receipt, BoP) and expected inflation rate (proxied by consumer price index) from 1986 to 2010 were obtained from World Development Indicators (WDI) and Global Development Finance (GDF) published by the World Bank and the International Monetary Fund (IMF). The official naira-dollar exchange rate (e_t) is calculated as an annual average based on monthly averages (in local currency units, LCU, relative to the U.S. dollar).

PRELIMINARY DIAGNOSTIC RESULTS

Integration (Unit Root) Result: Since standard inference procedures do not apply to regression models which contain an integrated regressand or regressor, it is imperative to check whether the series is stationary before using it for the estimation (Ekong and Onye, 2012:61). As Gujarati (2004:798) notes, "if a time series is not stationary, its behaviour can only be studied for the time period under consideration. Thus, an integrated process may be of little practical value for the purpose of statistical inferences such as forecasting or hypotheses tests". Table 3 report the Augmented Dickey- Fuller (ADF), Phillips-Perron (PP), and Kwaiatkowski-Phillips-Schmidt-Shin (KPSS) test results for a unit which enable us ascertain the stationary states of each of the variables. Results from the unit root tests would determine the procedure to be employed to estimate the coefficients of the FPMM, (2.9). This is because the stationary state of the individual series determines whether their linear combination is stationary, that is, whether the variables are cointegrated. For instance, if all series are **I**(0), then OLS may be used to estimate the coefficients, especially if the essence is not statistical inference; in contrast, if all series are **I**(1), then OLS would render a spurious regression result.

The ADF unit root test involves estimating (4.1) for each series and, then, testing the null hypothesis of a unit root, H0: α=0, versus the alternative of a stationary process, H1: α <0. This test is based on the typical t-ratio for α (Fuller 1976; Dickey and Fuller 1979). But the t-statistic does not follow the t-distribution under the null; thus, critical values are simulated for each regression specification and sample size (see MacKinnon, 1996).

$$\Delta y_t = \alpha y_{t-1} + x'_t\beta + \sum_{p=1} \Delta y_{t-p} + e_t \quad \text{---------------------(4.1)}$$

X'_t is exogenous regressor that may include a constant term only, a constant and a trend, or none while Δy_{t-p} are terms included to correct for higher order serial correlation.

The PP unit root test involves estimating a non-augmented version of (4.1), that is, without the lagged difference terms (augmentation terms). PP unit root test uses a non-parametric method to control for serial correlation under the null hypothesis, but the H_0 and H_1 are same as in the ADF test. However, the PP unit root test is based on its own statistic and corresponding distribution (Phillips and Perron, 1988).

The KPSS unlike the ADF and PP assume that the series is stationary under the null. KPSS tests the OLS residuals obtained from (4.2) based on the Langrage Multiplier (LM), where x_t is as defined in (4.1).

$$\Delta y_t = x_t'\beta + e_t \quad \text{--(4.2)}$$

In Table 3, we report the unit root test results.

Table 3: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin Unit Root Test Results:

			e	$m-m^f$	$y-y^f$	$\Pi^e - \Pi^{ef}$
Test statistics for Unit Root	ADF: drift	Level	-2.29	-2.53	-2.27	-3.75 ***
		1st diff.	-4.75 **	-5.07 ***	-4.68 ***	-4.54 ***
	ADF: drift & trend	Level	-2.02	-2.53	-2.51	-4.18 **
		1st diff.	-4.93 **	-5.07 ***	-4.56 ***	na
	PP: drift	level	-2.36	-2.04	-2.39	-2.85 *
		1st diff.	-4.75 ***	-3.06 **	-4.68 ***	-7.12 ***
	PP: drift & trend	Level	-2.02 **	-1.81	-2.63	na
		1st diff.	-4.93 ***	-3.74 **	-4.56 ***	-7.13 ***
	KPSS: drift	Level	0.70 **	0.15 **	0.22 *	-0.13
		1st diff.	0.29	0.25 *	0.04 *	0.03
	KPSS: drift & trend	Level	0.142 **	0.13 *	0.09 *	0.07
		1st diff.	0.06 ***	0.04 *	0.04 *	0.027 *

Notes: Ho: nonstationary (Unit root) process for ADF and PP; conversely, Ho: stationary process for KPSS; *, **, *** refers to the rejection of Ho at 10%, 5%, 1% significance level, respectively; number of lags in ADF test is selected according to modified Swartz Information Criteria (SIC).

Overall, the ADF and PP tests returned results that lead to the inability to reject the null hypothesis of a unit root at the 5% level of significance except for the expected inflation differential. This means all the variables except expected inflation differential contain unit roots (are non-stationary) at their levels. However, when the series were differenced, the ADF and PP returned results that led to the rejection of the null hypothesis of a unit root. Results from the KPSS are mixed, but in the main, they also show that most of the variables are nonstationary at levels. This means that the variables became stationary after taking the first difference. Having ascertained the stationary states of the individual variables, we proceed to test whether they are cointegrated. The result from the cointegration test will guide our choice of the regression technique to estimate the parameters of (2.9).

Cointegration Results

We test for cointegration among e_t, m_t-m^f_t, $y_t - y^f_t$, and $\Pi^e_t - \Pi^{ef}_t$ using the Phillips and Ouliaris (1990) residual-based (single equation procedure) and the Johansen (1988, 1991) system-based approach. Table 4 and 5 report the Johansen (1991) and Phillips and Ouliaris (1990) test results, respectively.

Table 4: Johansen Maximum Likelihood Cointegration Result

Hypothesiz d		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.792582	67.66235	47.85613	0.0003
At most 1 *	0.578134	31.48293	29.79707	0.0317
At most 2	0.331473	11.63240	15.49471	0.1754
At most 3	0.097944	2.370801	3.841466	0.1236
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

From table 4, the trace statistic of 11.63 (when compared to the critical value of 15.49) indicates that we can no longer reject the null of no cointegration. Thus, the test result indicates at most two cointegrating vectors at 5% significance level.

Table 5: Phillips Ouliaris cointegration Test Result

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
e	-1.876708	0.9014	-3.815286	0.9818
$m-m^f$	-2.551822	0.6683	-11.63852	0.5856
$y-y^f$	-3.122409	0.4086	-13.79277	0.4248
$\Pi^e - \Pi^{ef}$	-3.281462	0.3428	-13.55047	0.4422
*MacKinnon (1996) p-values.				
Warning: p-value may not be acc rate for fewer than 25 obervations.				

From table 5, the Phillips-Ouliaris tau statistic (t-statistic) and the normalized auto-correlation coefficients (called the z-statistic) both reject the null hypothesis of no cointegration (unit root in the residuals) at 5% level. Overall, the evidence clearly suggests that there is at least one cointegrating vector.

EMPIRICAL RESULTS

Estimate of cointegrating coefficients: As is clear from the previous section, if the series are cointegrated, ordinary least squares estimation (static OLS) of the cointegrating vector will be consistent, converging at a faster rate than is standard (Hamilton 1994). But an important shortcoming of static OLS (SOLS) is that the estimates have asymptotic distribution that is generally non-Gaussian, exhibit asymptotic bias, asymmetry, and are a function of non-scalar nuisance parameters. The non-Gausian (problematic) asymptotic distribution of SOLS arises due to the presence of: (1) cross correlation between the cointegrating equation errors and the regressors; and 2.) long-run correlation between the cointegrating equation errors and the regressor innovations. In the special case where the regressors (X_t) are strictly exogenous, the bias, asymmetry, and dependence on non-scalar nuisance parameters vanish, and the SOLS estimator has a fully efficient asymptotic Gaussian mixture distribution which permits standard Wald testing using conventional limiting chi-distribution. In contrast, the FM-OLS and DOLS estimates are asymptotically efficient and yield covariance matrices appropriate for inferences (Rapach and Wohar 2002: 364; EViews 7.0, p. 221). Since conventional testing procedures are not valid unless modified substantially, SOLS is generally not recommended if one wishes to conduct inference on the cointegrating vector. Thus, the fully efficient estimation methods supported by EViews, namely, FM-OLS and DOLS involve transforming of the data or modification of the cointegrating equation specification to mimic the strictly exogenous X_t case (see equation 4.3).

Provided all series are in general I(1), as is the case from table 3, the DOLS and FM-OLS are employed to estimate the cointegrating vectors that characterizes the long-run relationship between nominal exchange rate and the monetary fundamentals. We regress the log of naira-dollar spot exchange rates on contemporaneous levels of the monetary fundamentals, leads and lags of their first difference, and a constant, using ordinary least square (Stock and Watson, 1983:784). This type of regression model is called the dynamic ordinary least square (DOLS) regression. The Stock and Watson (1993) DOLS model is specified as follows:

$Y_t = \beta_0 + \beta_1 X + \sum_{j=-q} d\Delta X_{t-j} + u_t$ --------------------------(4.3)

Y_t = dependent variable; X = matrix of explanatory variables; β_1 = cointegrating vector which represent the long-run cumulative multiplier of long-run effect of a change in X on Y; p = lag length; q = lead length.

Lag and lead terms are included in DOLS regression for the purpose of making its stochastic error term independent of all past innovation in the stochastic regressors. Including Leads and lags of ΔX_t removes long-run dependence by orthogonalizing the equation residual with respect to the history of stochastic regressor innovations (EViews 7.0, p.231). Thus, the presence of lags and leads of different variables in the DOLS model, which has a cointegrating vector, eliminates simultaneity bias (Stock and Watson, 1993). The FM-OLS employs a semi-parametric correction to eliminate the problems caused by the long run correlation between the cointegrating equation and stochastic regressors innovations. All of the descriptive and fit statistics are computed using the original data, not the FM-OLS transformed data. So, the measures of fit and DW statistic may not be, strictly speaking, valid.

Table 5: Dynamic OLS (DOLS) and Full Modified OLS (FM-OLS) Estimates Cointegration Coefficients.

Estimation technique	variables	coefficients	t-statistics	R^2	long-run variance
FM-OLS	constant	0.17	-1.2	0.89	0.24
	$m-m^f$	-0.66	-1.26		
	$y-y^f$	-0.31	-1.82		
	$\Pi^e - \Pi^{ef}$	-0.08	-0.52		
DOLS	constant	-1.56	-0.69	0.94	0.21
	$m-m^f$	-0.22	-0.21		
	$y-y^f$	-0.44	-1.23		
	$\Pi^e - \Pi^{ef}$	-0.23	-0.89		

Table 6 indicate that all coefficient of the monetary model, except real income differential fail to meet the a proiri expectation imposed by the monetary model as specified in section 3.1.

The Failure of Long-run PPP relation for naira-dollar exchange rates: We have noted that the building block of the monetary model of exchange rate determination is the assumption that purchasing power parity (PPP) is at least a long-run phenomenon. From table 3, we note that the nominal naira-dollar exchange rate and relative prices (CP1) are I*(1).* Attempts at finding a cointegrating relationship between the nominal exchange rate and relative prices are reported in table 7 with equation 4.4 estimated in fellowships with Baillie and Selover (1987:49).

$e_t = \alpha + \beta(\Pi_t - \Pi_t^f) + u_t$ ----------------------------------(4.4)

The cointegration null that the residuals (u_t) are I(1) could not be rejected for the naira-dollar exchange rate; so that no cointegrating relationship could be found. Thus, exchange rates and relative prices (inflation differential) will apparently drift apart without bounds. While PPP has been a convenient assumption in the monetary models, Pigott and Sweeney (1985) have noted that permanent departures from PPP can arise from changes in productivity and tastes and shifts in comparative advantages, and have acknowledged the possibility of divergence from PPP. Other empirical studies by Adler and Lehman (1983) and Taylor (1986) provide confirmatory empirical evidence of this fact.

Table 6 Estimates of $e_t = \alpha + \beta(\Pi_t - \Pi_t^f) + u_t$

country	α	β	DF Statistic*
NIG-U.S.	3.79 (5.52)	-0.13 (-0.37)	-2.34

*DF is the Dickey Fuller statistic to test for a unit root in u_t The critical values are -3.73, -2.99 and -2.63 at 1%, 2% and 3% significance level respectively while the figure in parentheses are the t statistic.

CONCLUSIONS AND RECOMMENDATIONS

The results presented in this paper appear to provide more dismal evidence on the inappropriateness of the monetary model for the naira-dollar exchange rate determination. The finding that there is at least one cointegrating vector between nominal naira-dollar exchange rate and the monetary fundamentals does not necessarily validate the monetary model as the estimates of the cointegrating parameters were inconsistence with the values predicted by the monetary model. The test of validity of the long-run PPP assumption, a major building block of the monetary model, provides even more supportive evidence on the failure of the monetary exchange rate model. The result indicates that exchange rates and relative prices (inflation differential) will apparently drift apart without bounds in the long-run as the cointegration null that the residuals in (4.4)) are I(1) could not be rejected. This does not implies that monetary variables are not important in predicting exchange rate movements but shows that the FPMM and its simple extensions may have been misspecified as a long-run relationship.

We suggest that it is more appropriate to consider multinational models of exchange rate determination to allow for common macroeconomic effects, that is, to capture the influence of economic magnitudes that are common to countries. This idea have been acknowledged in related studies by Edward (1983), Hakkio (1984) and Baillie and Selover (1987:44) who use the fact that change in level of one exchange rate will be useful information in predicting the level of other exchange rates. We consider the multinational models to be more viable for predicting exchange rate movements especially among countries with synchronous or symmetric inter-country influences/ shocks (Ekong & Onye, 2012).

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