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Examining the Behavior of Exchange rate in Nigeria: An Application of the Pinto Model

Ferdinand C. Nwafor, Ph.D.
Baze University, Abuja, FCT
Email: nwafor.ferdinand@gmail.com

Abstract
A non-traditional model of exchange rate behavior, namely, the Pinto model is examined within the confines of a reduced-form linear stochastic model with respect to the Nigerian naira and the U.S. dollar from 1980-2012. This Pinto model hypothesizes a parallel rate that is assumed to reflect market fundamentals and influenced by the following exogenous variables: an inflation rate, broad money supply, terms of trade, the official naira dollar exchange rate as a policy variable, and the level of fiscal deficits. Applying the unit root tests on the determinants suggest that the time series data might be spurious and thus necessitate co-integration application. The results indicate a long run co-integrating vector between the naira-dollar parallel exchange rate and its aforementioned determinants.
Keywords: Parallel Exchange Rate, Dutch-disease Syndrome, Non-traditional, Co-integration

1. Introduction

Although the bulk of the empirical research on exchange rate behavior has been done on developed or industrial nations, very few of these studies have focused on applying a non-traditional model of exchange rate determination. Therefore, the purpose of this study is to examine exchange rate behavior in Nigeria by deviating from the conventional models of exchange rate determination in order to capture the relevant variables influencing the Naira-Dollar exchange rate from 1980-2012. This period is significant because of the emergence of the parallel exchange rate and the possibility and sustainability of exchange rate convergence in Nigeria. For example, an investigation of official exchange rates (from IMF publications) and the black market exchange rates (reported in World currency Yearbook and Pick's Currency Yearbook) indicates a robust black market for foreign currencies in Nigeria. To this end, there were substantial changes in the value of the Nigerian currency, the Naira, which has been made partially convertible since August 1974. In addition, given oil exports and remittances from Nigerians abroad, the openness of the Nigerian economy suggests an investment in the foreign exchange market. This paper follows with a review of the Nigerian Economy, the Pinto model, methodology, data analysis, and concluding remarks, respectively.

2. Review of the Nigerian Economy

The growth of the Nigerian economy in the 1970s could be traced to increase in oil exports, large public sector spending, and massive borrowing from abroad. The sharp increases in oil revenue in 1973-74 and 1979-80 transferred a large amount of wealth to Nigeria, hence transformed the economy. For instance, in 1974-78 the average growth rate of real GDP amounted to 6.5 percent per year. However, the dominance of oil in the Nigerian economy provided evidence of "Dutch-disease syndrome" as the agricultural sector which is the main non-oil tradable sector declined. In the Nigerian setting, the oil boom led to a shift in the domestic production structure in favor of non-traded goods as traded goods were replaced by cheaper imports. During 1976-77, the federal government budget was in deficit as a result of large spending sprees by the government initiated mainly by the oil boom. For example, the government spending included the Udojie Awards of 1975 in which salaries of civil servants were increased by over 100 percent. Also, between 1980 and 1983, oil export earnings reduced from $23.4 billion to $9.9 billion due to worldwide recession. The result included large external and internal deficit plus a decline in foreign reserves, even as the country began to borrow heavily accumulating about $6-7 billion of external payment arrears, part of which went to finance public development programs, such as the steel industry. Consequently, Nigeria's competitive position fell as the official value of the Nigerian currency, namely the Naira (N), became detached from its value in trade as indicated by the rise in the parallel market premium.

From 1980-85, economic growth stalled as real output declined by over 10 percent. With real output and domestic production falling, high inflation and the deteriorating foreign exchange reserves implied that the monetary authorities could not continue to support the gradual realignment in the volume of the naira. Moreover, the external payments position was worsened by rising interest rates in world financial markets, thereby aggravating Nigeria's interest payments on external debt from 0.6 percent of total export earnings in 1978 to 9.7 percent in 1985. In response to the economic crisis, the federal government adopted a strategy of economic austerity measures such as strict foreign exchange controls, credit ceilings, and cuts in public investment expenditures. Despite further tightening of the exchange controls and increases in import demand restrictions, the fiscal positions of the federal and state governments continued to worsen.

The deteriorating economic conditions led to the adoption of the structural adjustment program (SAP) designed with the assistance of the World Bank to be implemented from June 1986 to July 1988. The objective of the SAP included the following: To restructure and diversify the productive base of the economy in order to reduce dependence on oil and imports; to lay foundation for long-term economic growth by encouraging exports; to strengthen fiscal balance of payments position; to improve the efficiency of the public sector; and to intensify the efficacy of the private sector's growth potential. In fact, the main strategies of the SAP included the adoption of realistic exchange rate policy together with liberalization of the external trade and payments system and the adoption of appropriate pricing policies in all sectors with more reliance on the market system and reduction in complex administrative controls. As such, the Second-Tier Foreign Exchange Market (SFEM) was launched in September 1986 in order to help correct the overvaluation of the naira exchange rate. In 1987, the SFEM and the first-tier rate – which was kept for an interim period with its use reserved for debt service and public sector payments to foreign organizations and embassies were combined as the Foreign Exchange Market (FEM) system. This system was in place through the period indicated in this study.

The Nigerian economy has remained underdeveloped largely because of non-diversification of the economy. Nigeria still derives 95 percent of its foreign exchange earnings from oil and approximately 80 percent of its budgetary revenues depend on oil proceeds. After the debt agreement in 2000, Nigeria signed a debt agreement with the Paris Club and received a $1 billion credit from the IMF to embark on economic reforms. In 2005, Nigeria received another debt restructuring agreement with the Paris Club to offset $18 billion of debt in exchange for $12 billion in payments. In 2008, the Federal Government of Nigeria (FGN) started implementing economic reforms – banking system reforms, removal of oil subsidies, and other interventions like in the areas of power, aviation, and agriculture. In any case, a realistic exchange rate policy is critical to macroeconomic reforms and stability.

3. The Pinto Model

As Ayogu (1995) postulates, the official exchange rate of Nigeria did not reflect economic fundamentals, given that it is not co-integrated with the parallel rate. This implies that the parallel rate does reflect economic fundamentals. Following Pinto (1987, 1989), the prices of traded goods in Nigeria are more likely to reflect the parallel or black market rate. This assertion is based on the fact that exchange rate is rationed in the official market where the naira is somewhat nonconvertible. On the other hand, the naira is freely convertible in the parallel market. In view of the above, this study also examines the market-determined parallel exchange rate as an endogenous variable, while the official rate is considered a policy variable and hence, treated as an exogenous variable.

The Pinto model hypothesizes a parallel rate (PN$) that is determined by the following exogenous variables: an inflation rate captured by the GDP price deflator, the money supply (M2), the terms of trade (TOT) in form of oil prices, the official naira-dollar exchange rate, and the level of fiscal deficits (FD). The official naira exchange rate is used as an explanatory variable in accordance with the CBN policy of achieving unification of parallel and official rate. In line with the methodology of Kadhim and Almahmeed (1990), and Boughton (1987), the following Pinto (1989) model is therefore augmented in a version of reduced-form linear stochastic model and hereby posited as:

$E = XB + U, \quad (1)$

Where, E = vector of observations of endogenous variable with dimensions t x I;

X = matrix of observations of exogenous variable t x k; $X_{t1} = 1,\ldots, n$

B = vector of true disturbances with dimensions t x 1;

T = 1, 2, ---n, k = 1, 2, ---m, with n and m the number of exogenous variables, respectively.

Thus, the model hypothesizes that the parallel naira-dollar exchange rate is determined by the following exogenous variables: P, M, TOT, ND, and FD; where,

E = PN$, that is, the parallel naira-dollar exchange rate;

X_{t1} = P, is the expected inflation rate

X_{t2} = M, the monetary supply M2

X_{t3} = TOT, the terms of trade

X_{t4} = ND, the official naira-dollar exchange rate; and

X_{t5} = FD, the fiscal deficit

Log-linearizing the model yields the following long-run parallel spot rate equation:

$InPN\$_t = b_o + b_1InP_t + b_2InM2_t + b_3InTOT_t + b_4InND_t + b_5InFD_t + U_t$ (3)

Where, U_t is an error term, which is assumed normally distributed with mean zero.

Theoretically, it is assumed that the expected coefficient of the ND is positive on the basis of the expectations hypothesis. Essentially, any rise in exchange rate today is more likely to follow the same pattern in the future. Moreover, the expected coefficient of ND is positive because of the CBN's (Central Bank of Nigeria's) policy of maintaining the equilibrium value of the Naira relative to foreign currencies, especially from early 1970s to mid of 1980s. In addition, the naira-dollar exchange rate is expected to be positive in other to close the gap between the parallel market rate and the official market rate. In other words, any reduction in the parallel market premium would eliminate the disequilibrium in the foreign exchange market with respect to the naira-dollar exchange rate. Nevertheless, evidence has shown that prior to the introduction of the SAP and the ensuing devaluation policy, a revaluation policy occurred. Thus, suggesting that the expected sign of ND could be either positive or negative.

Moreover, the expected sign of the coefficient of TOT in general should be negative because an improvement in the terms of trade of a country is bound to reflect favorably on its foreign exchange rate. In the Nigerian situation, as more foreign exchange become available, less pressure is exerted on the exchange rate premium. Since oil price is used as a proxy for TOT, it is expected that the coefficient would respond in a similar manner as TOT.

Furthermore, the expected sign of the P coefficient is positive. Thus, as the inflation rate increases, the naira exchange rate rises, leading to a depreciation of the spot parallel naira exchange rate (PN$).

Also, it is assumed that the fiscal deficit has ambiguous effects with respect to exchange rate movements in Nigeria. Thus, an increase in fiscal deficit financed by external borrowing will initially induce an appreciation due to influx of foreign exchange, whereas, a rise in fiscal deficit financed by government revenues will lead to an increase in the parallel rate, a depreciation.

Finally, increase(decrease) in the money supply will cause a rise (decline) in imports, and therefore, boost(lower) the demand for foreign currency (dollars), a(an) depreciation (appreciation) with a stable supply of foreign currency (dollars). Essentially, the M2 coefficient is expected to be positive.

4. Methodology

This study assumes implicitly a regime of floating exchange rate with no government intervention, although this assumption does not absolutely reflect the Nigerian case. Because the government occasionally intervenes in the foreign exchange market, the floating rate system is managed. In testing the Pinto model (PM), a two-country model of Nigeria and the United States is examined with respect to the naira-dollar exchange rate, where Nigeria is the home country. The period covers 1980 to 2012 annually. Data sources include the Central Bank of Nigeria (CBN), IMF International Financial Statistics (IFS) and World Economic Outlook.

In line with Gujarati and Porter (2009), regression models involving time series data sometimes give results that are spurious – correlation could persist in non-stationary time series even if the sample is very large. In other words, implying that the series might be non-stationary or contain unit root – a persistent time series process in which current value is the same as lagging value, in addition to a weakly dependent disturbance (Wooldridge, 2006). The ADF (Augmented Dickey Fuller) test is employed to test for the existent of unit root. According to Greene (2003), the ADF test for unit root is formulated as:

$$W_t = \mu + \eta W_{t-1} + \sum_{i=1}^{n} \gamma_j \Delta W_{t-I} + \mu_t \quad \text{..... (1)}$$

Where the ADF unit root test hypothesizes a null of $\eta = 0$ versus an alternative $\eta < 0$. Thus, if the series contain unit root, then co-integration is necessary.

Employing the co-integration methods of Johansen and Juselius (1990) given a VAR (Vector Autoregression) model such as:

$$\Delta X_t = \Sigma \Gamma_i \Delta X_{t-I} + \Omega X_{t-I} + \mu + E_t \quad \text{..... (2)}$$

Where X_t is the vector of non-stationary variables ρ x 1 and i = 1,……,k to yield co-integrating vectors or none as captured by the trace and maximum eigenvalue tests.

As such, the Johansen and Juselius procedure verifies if the coefficient matrix Ω captures the fundamentals of long run equilibrium consistent with the non-stationary variables. In essence, if $0 < \text{rank } \Omega = r < \rho$, then there are matrices α and β of dimension ρ x r, where $\Omega = \alpha\beta$ and there are r co-integrating relations among elements of X_t, where α and β are co-integration vectors and error correction parameters, respectively (Nwafor, 2008).

5. Data Analysis

5.1 Ordinary Least Squares

Table 1: OLS Estimates
Dependent variable: PN$
No. of observations = 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-83.72802	66.58286	-1.257501	0.2193
P1	0.907744	6.550395	0.138579	0.8908
M21	1.522196	11.78433	0.129171	0.8982
TOT1	39.00612	20.29789	1.921683	0.0653
ND1	23.00965	9.672550	2.378861	0.0247
FD1	-12.67620	7.855526	-1.613666	0.1182

R-squared	0.926965	Mean dependent var	66.75727
Adjusted R-squared	0.913440	S.D. dependent var	65.26625
S.E. of regression	19.20203	Akaike info criterion	8.910874
Sum squared resid	9955.382	Schwarz criterion	9.182967
Log likelihood	-141.0294	Hannan-Quinn criter.	9.002425
F-statistic	68.53722	Durbin-Watson stat	0.927531
Prob(F-statistic)	0.000000		

The Ordinary Least Squares (OLS) estimates show a fairly high R^2 statistic, highly auto-correlated residuals as evidenced in the low Durbin-Watson (d-w) statistic, and thus the t and F tests on the regression parameters are likely to be spurious. Therefore, it seems that the OLS estimator is not converging in probability as the sample size increases, and the t and F test statistics do not exhibit a defined asymptotic distribution, and the d-w statistic converges towards zero. Most of the signs for the explanatory variables are in line with the theory, but evidence shows that with the parallel rate and P, M2, TOT, ND, and FD might be integrated of order one, I(1), variables, where the error term u_t seems to be a non-stationary I(1) variable.

5.2 Unit Root Tests

A test of the time-series properties of the data using the Augmented Dickey Fuller (ADF) test indicates that all the variables have unit roots when tested with a time trend and\or a constant, except for the FD variable. That is, the autoregressive distributed lag (ADL) functions of the variables are I(1) series (integrated of order one). This implies that most of these variables are first-order homogenous and non-stationary and therefore, may show some spurious correlations as shown in Table 2 below. Thus, co-integration test is necessary.

Table 2: ADF test Statistics for Unit Roots

Variable	t-Statistic	Critical Values
P	-1.66	2.96
M2	0.21	2.96
TOT	-1.96	2.96
ND1	1.79	2.96
FD	-5.32.	2.96

5.3 Co-integration

Table 3: Co-integration Tests
Sample (adjusted): 1982 2012
Included observations: 31 after adjustments
Trend assumption: Linear deterministic trend
Series: P1 M21 TOT1 ND1 FD1
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.702213	77.75252	69.81889	0.0101
At most 1	0.463759	40.19986	47.85613	0.2154
At most 2	0.329487	20.88154	29.79707	0.3651
At most 3	0.198011	8.490449	15.49471	0.4145
At most 4	0.051833	1.649978	3.841466	0.1990

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 *	0.702213	37.55266	33.87687	0.0174
At most 1	0.463759	19.31832	27.58434	0.3903
At most 2	0.329487	12.39110	21.13162	0.5096
At most 3	0.198011	6.840471	14.26460	0.5082
At most 4	0.051833	1.649978	3.841466	0.1990

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

Johansen co-integration indicates one co-integrating vector suggesting that the parallel rate is I(0). As such, the equilibrium error is stationary and fluctuating within zero as illustrated above in table 3 by the trace and maximum eigenvalue tests results.

6. Concluding Remarks

The exchange rate behavior in Nigeria as captured by the market fundamentals such as inflation, broad money supply, terms of trade, the official naira dollar exchange rate, and fiscal deficits are somewhat co-integrating with the parallel rate as hypothesized by the augmented Pinto model. Thus, the CBN should consider exchange rate behavior not only in the context of traditional models but non-traditional models as envisaged by Pinto.

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