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EXCHANGE RATE REFORM AND ITS INFLATIONARY CONSEQUENCES: THE CASE OF NIGERIA

This paper examines the impact of price response to exchange rate changes in Nigeria, using annual data from the period 1970 to 2003. A vector error correction (VEC) model and slope-dummy methodology were estimated in order to determine the significance of government policy shift (exchange rate reform) on inflation. Evidence from the paper reveals that exchange rate policy reform is important in the determination of inflation in Nigeria. The forecast error variance decomposition results may imply that money supply and exchange rate exerted stronger dynamic effects on inflation forecast errors than output level. However, the slope-dummy results confirmed the impotence of exchange rate (flexible) policy reform on inflation. The paper suggests that whereas, a stable, consistent and complementary policy on money supply and exchange rate is required for price stability, the domestic output expansion (particularly agricultural output) is needed to meet the ever-growing food demand in Nigeria.

Keywords: Nigeria, exchange rate, inflation, money supply, slope dummy, vector error correction

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I. Introduction

In terms of economic history, Nigeria has indeed come a long way. Since political independence on 1st October, 1960, the Nigerian nation has suffered from civil strife and 'stop-go' economic policies which have resulted in high inflation and serious macroeconomic instability. Understanding the sources of the instability is an important challenge to empirical macroeconomists and policy makers. The reason for this challenge is related to the vast wealth of natural resources available in the country and particularly crude oil and natural gas whose huge export revenue has driven the Nigerian economy since the 1970s, yet the economy has not experienced substantial growth and development.

The dominance of oil in the Nigerian economy has been factored as perhaps the greatest hindrance to its economic progress as it created a boom-and-bust mode of economic management. The oil boom of the 1970s, as a concomitant of soaring international oil prices, resulted in substantial resources by way of government revenue and foreign exchange earnings. This encouraged expansion of the public sector expenditure in a bid to hastily develop the productive capacity of the economy and improve the living standard of the people. The public sector in the 1980s, for instance, accounted for about half of the gross domestic product (GDP) and two-thirds of employment in the modern sector (Mbanefoh, 1993:194). A composite consequence of this was a marginal progress made in some sectors on the one hand; and on the other hand, wasteful investments expenditures on unviable and questionable projects. In the early 1980s there was a near total collapse of international oil market. The dips in international oil prices aggravated the problems of the Nigerian economy; especially as foreign exchange earnings declined and letters of credit were dishonoured.

The catalogue of the structural distortions in the economy, which is adequately documented in the literature, made Nigeria to embark on a vigorous programme of adjustment and reform beginning from 1986. The core objectives of the adjustment and reform programme include the adoption of a realistic foreign exchange rate policy, stimulation of domestic production and broadening of the supply base of the economy, improved trade and payment liberalization and privatization of public sector enterprises among others (Soludo, 1993:51). Generally, the Structural Adjustment Programme (SAP), emphasized a comprehensive reform process towards a market economy.

Undoubtedly, the search for a realistic exchange rate in a depressed economy like Nigeria at that time through currency devaluation was bound to generate inflationary pressures as most of the imported goods had no close domestic substitute. Soludo (1993:54) in reference to Singh (1986:87) emphatically stated that even the Chicago and Cambridge Schools of Economics, though differ over their views on the functioning of economic systems, they however agreed that delib-

erate adjustments of exchange rate is not a suitable method of structural change since such generate inflation.

Exchange rate adjustment and the inflation nexus have been discussed in some studies (see, Weir, 1986; Shapiro, 1988; Edwards, 1989; Agenor, 1991; Rogers and Warg, 1995; Kamin and Rogers, 1997; Kamin and Klau, 1998; Zhang, 2000; Odusola and Akinlo, 2001; Phylaktis and Girardin, 2001; Kara and Nelson, 20002 and Lu and Zhang, 2003). At the core of this discussion is the determination of the inflationary costs of devaluation. It is thus critical to assess the extent to which exchange rate adjustment and reforms would have affected Nigeria's domestic prices.

This paper is therefore an attempt to empirically analyse how prices responded to exchange rate changes in Nigeria and how the policy shift during the period under review had impacted on the exchange rate and hence prices. Although a recent study by Odusola and Akinlo (2001) had earlier undertaken this path, this paper also attempts to fill the gaps identified in that study[1].

Odusola and Akinlo (2001) by applying the restricted vector autoregressive (VAR) model demonstrated how devaluation impacted on output and prices (inflation) in Nigeria. Quarterly values of real Gross Domestic Product (GDP), money supply (broad money), official exchange rate, parallel exchange rate, prices (consumer price index; CPI) and lending rates were used in the study for the period 1970.1-1995.4. Quarterly GDP was interpolated through exports given that only annual GDP is published in Nigeria. Evidence from the study revealed that official exchange rate shocks were followed by increased prices, money supply and parallel exchange rate.

Although, the use of interpolation may be academic, the disadvantages of down-scaling or disaggregating annual data into quarterly data as noted by Barrow (n.d.) are worrisome. Some of the limitations (See Barrow, www.cics.uvic.ca/scenarios/pdf/workshop/downscaling/pdf) among others are summarized below:

- a large amount of observational data is required to establish its statistical relationships for current scenarios.
- specialist knowledge is required to apply the techniques correctly,
- relationships are only valid within the range of the data used for calibration, etc.

The present paper differs from that of Odusola and Akinlo (2001) in several ways. First, it uses annual data (1970-2005). The use of annual data finds support in Hakkio and Rush (1991) position, that increasing the number of observations by using monthly or quarterly data does not add any robustness to the results especially in series which involve tests of cointegration. Secondly, the present paper further applies a slope dummy methodology in order to determine the economic

[1] An adequate review of previous studies is presented in Odusola and Akinlo (1991).

and statistical significance of government policy shifts (exchange rate deregulation) on inflation. The reason is because VAR is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. In this paper, the VAR will also be used to estimate the impulse response functions and variance decompositions of price level in order to determine how price responses to a shock in exchange rate, and what proportion of price level variance can be explained by the exchange rate changes. Granger causality test is also used to show the likely feedback effects that exist between the variables. This was assumed away in Odusola and Akinlo's (2001).

This paper is organized into six sections. Following the introduction, section II briefly reviews related studies. In section III, a brief overview of the Nigerian economy is discussed while in Section IV, the model to be estimated is presented. Section V discusses the findings of the analyses, while Section VI concludes the paper.

II. Review of Related Studies

Inflation remains one of the most debated macroeconomic issues. In its simplest and crude form it means a persistent tendency for general prices to increase. Its causes have been attributed to both domestic and international determinants; which include exchange rate volatility, money supply, sectoral disequilibria, etc. Although several studies (for instance, Giovanni, 1988; Khan, 1989; Chhiber and Fisher, 1991; Younger, 1993; Ndung'u, 1993; Egwaikhide, Chete, Falokun, 1994, Morris, 1995; Copelman and Wermer, 1996; Kamin, 1996; Dordunoo and Njinkeu, 1997; Hooper and Doornik, 1999; Phylaktis and Girardin, 2001; Nnanna, 2002; and Lu and Zhang, 2003) on the exchange rate-inflation nexus have gone full cycle, a general consensus on the impact of exchange rate changes on inflation is yet to be achieved. Among existing empirical studies, Odusola and Akinlo (2001) presented a detailed review of some previous studies which have utilized VAR models.

Montiel (1989) applied a five-variable VAR model (money, wages, exchange rate, income and prices) to examine sources of inflationary shocks in Argentina, Brazil and Israel. The findings indicate that exchange rate movements among other factors significantly explained inflation in the three countries. Other studies which have reached similar conclusions are Kamin (1996), Odedokun (1996), Elbadawl (1990), Nnanna (2002) and Lu and Zhang (2003).

Lu and Zhang (2003) study of China observed that in the short-run, changes in the devaluation rate are positively correlated with the increase in the inflation rate. The findings shed some light on China's exchange rate policy reform, which was aimed at transforming its overvalued currency into a meaningful economic lever.

Several other studies which have countered the positive exchange rate – inflation nexus are 'those by Kamas (1995) on Colombia, which observed that ex-

change rates did not play an important role in explaining the variation in inflation of Colombia. Kamas further highlighted that inflation in Colombia appeared to be primarily of inertia with respect to exchange rate but largely determined by demand shocks.

Kara and Nelson (2002) study of the UK found that neither of the above extremes had justification in empiricism. Rather, in line with Campa and Goldberg (2002) analysis of the UK, the data reported a close and high correspondence between exchange rate changes and rates of change in prices of products labelled as imported consumer goods. Kara and Nelson (2002) observed that whereas, there is low correlation between domestic price (inflation) and nominal exchange rate changes, the correlation between 'import price inflation' and nominal exchange rate changes is however high.

In some other studies, the relationship between exchange rates and inflation has been investigated along the synthesis of monetarist and structuralist theories. The monetarists regard inflation as a purely monetary phenomenon, caused and sustained by expansionary money supply. The structuralists on the other hand argue that structural rigidities such as food prices and wage or exchange rate changes in developing economies create structural vulnerability (Barungi, 1997). Fitzpatrick and Nixson (1976) however maintained that though an increase in money supply is a necessary condition for the rise in the overall level of prices, it is not a sufficient condition. Some other notable studies that have applied alternative inflationary models that include the exchange rate as a determinant of inflation other than VAR methodology are: Chhibber and Shafik (1990); Egwaikhide, Chete and Falokun (1994); Gross and Schmitt (2000), and Omotor (2005a) among others. In summary, most of these studies cited above posited that devaluations are associated with increase in inflation. However, few studies have applied the VAR approach on studies of inflation in Africa countries, including Nigeria. This study therefore uses the VAR approach in establishing the determinants of inflation in Nigeria, within the context of an exchange rate anchored model. The section that follows therefore presents a review of exchange rate trend, inflation, monetary aggregate among other economic development fundamentals, with the objective of providing a general framework for understanding the mechanism of price formation in Nigeria.

III. Brief Overview of the Structure of the Nigerian Economy

Works and studies on the structure of the Nigerian economy since she gained political independence from Britain in 1960, abound (some examples are: Oladokun et al., 1979; Ekuerhare, 1997; CBN, 2000; Adedipe, 2004). In this section, we review the changing pattern of some key fundamentals as they relate to the Nigerian economy but not restricted to exchange rate, inflation and monetary aggregates. The key highlights are following:

• Nigeria has a land mass of 923,768 square kilometres with an estimated population of over 133 million, 5.6 percent annual GDP growth and 62 percent adult literacy rate in 2006. Nigeria operates a presidential system of government.

• Nigeria had an agrarian dominated Gross Domestic Product in the 1960s up to the early 1970s given that the ratio has dropped from 64.1 percent in 1960 to 41.2 percent in 2006. Relative to other sectors of the economy, the agricultural sub-sector has consistently had the largest share of real GDP.

• A leading oil-producing country; the largest in Africa and ranks the 7th largest producer in the world. The contribution of the oil sector in terms of its relative share of GDP, total government revenue and foreign exchange from exports have been tremendous. The oil sector contribution to Nigeria's GDP stood at an average of 36.43 percent (2000 – 2006) from a mere 0.3 percent in 1960. Oil exports as at 2006 contributed over 90 percent of foreign exchange earnings.

• Existence of dualistic markets (formal and informal). Activities in the informal market have been difficult to measure. Some sources put it at between 45 percent and 48 percent of all economic activities in Nigeria. This makes policy formulation very difficult.

• The Nigerian financial system is one of the fastest growing universally in recent years since the banking sector re-capitalization in 2005. Although the sector has had cycles of stability/prosperity and distress, there has been improved enforcement of regulations and increased commitment to corporate governance (Adedipe, 2004). Since 2006, entry into the banking system is difficult given the reform policy rules and regulations guiding the financial system. It may be interesting to note that the number of commercial banks in Nigeria increased from 34 in 1987 to 54 in 1999. Since 2006, the number of deposit money banks stands at 25 due to 2005 banking sector reform. Public sector confidence in deposit money banks which was eroded in the early 2000 has also increased. The banking sector credit market has also undergone substantial growth in favour of credit to the private sector. With the banking reforms the banking system credit share of the Federal Government of Nigeria which has been the major borrower has been on the decline. At the end of December 2006, the Nigerian financial system comprised the Central Bank of Nigeria (CBN) and the Nigerian Deposit Insurance Corporation (NDIC), the Securities and Exchange Commission (SEC), the National Insurance Corporation (NIC), and National Pension Commission (NPC) as regulatory bodies. Other operators are 25 deposit money banks, 750 community banks (CBs, currently converting to micro finance banks); 112 financial companies (FCs), 322 bureau de-change (BCs), 1 stock exchange, 1 commodity exchange, 5 discount houses, 91 primary mortgage institutions, 5 development finance institutions, 103 insurance companies, 581 brokers (CBN, 2006). Moreover, the financial sector has been deepening especially with broad money supply to GDP ratio. The increased trading activities and participation at the Stock Exchange have aided capital availability of investment funds among others.

• Inflation like in other developing countries especially sub-Sahara Africa has had its bitter toll on the Nigerian economy. Both monetary and fiscal policies among others have been deployed to arrest it. The Central Bank of Nigeria (CBN) has a statutory responsibility of formulating and implementing monetary policy with emphasis on price stability. Inflationary trend has been cyclical since mid 1970s peaking at various times (1975, 1990, 1996 and 2000). One major factor that has been responsible for inflation in Nigeria is poor fiscal management by all tiers of government. However, inflation since 2006 has reduced to single digit of 8.4 percent on the average unlike the double digits experience since the 1980s.

• In 1970 broad money supply (M_2) stood at ₦949.9 million. It rose to ₦23, 818.6 million in 1985. At end-2006, M_2 stood at ₦3, 190.9 billion. This astronomic growth rate no doubt can be inflationary especially if output growth is not proportional. Factors responsible for this growth in the monetary aggregates are the monetization of foreign reserves, inadequate financial policy framework, and poor institutions among others. A good number of these factors have been improved upon in recent times.

• Prior to the end of 2006, Nigeria was one of the highest indebted nations, owing huge sums of money to various international creditors. The exit from this class of countries was secured in 2006 and sealed in 2007 after the debt cancellations and subsequent pay-off of outstanding debts to the Paris Club among other creditors.

• Living standards in Nigeria vis-à-vis poverty profile has been very poor. For instance, the 2006 Nigerian Core Welfare Indication (CWI) survey by the National Bureau of Statistics showed that the dependency ratio, defined as total number of household members aged 0 – 14 years and 65 years and above to the number of household members aged 15 – 64 years, was 0.8. This implied almost a one-to-one dependency ratio and a reflection of the high population growth rate of Nigeria.

• Exchange rate stability has been an issue of concern especially since 1986 when a system of market-determined exchange rates through the Second Tier Foreign Exchange Market was introduced under the Structural Adjustment Programme (SAP). Prior to 1986, the fixed exchange rate system was operational. Instability in the naira's exchange rate until 2006 was a unidirectional depreciation in all markets. However, for the first time in 2006, the exchange rate has been stable with convergence of rates among the various segments of the foreign exchange markets (Official market/Interbank Foreign Exchange Market, Bureau de Change and Parallel Markets). At present (2008), the Nigeria's naira exchanges for an average of ₦117/US $1 as against ₦281.7/US $1 in the parallel market in 1995. This implied that the naira has been appreciating over the United States dollar (US$); as other comparative major currencies have also witnessed a depreciation against the naira. Since early 2006, the Wholesale Dutch Auction System (WDAS) has been introduced in the stabilization of the foreign exchange market with successful results.

• Nigeria's current goal is to become one of the top 20 economies in the world by the year 2020.

In summary, Tables 1a, 1b and Figure 1 vividly display some of the structural changes that the Nigerian economy has experienced since 1970.

Figure 1.

GRAPHICAL DISPLAY OF TIME SERIES VARIABLES OF INFLATION INDEX (CPI), EXCHANGE RATE (EXR), OUTPUT GAP (Y), MONEY SUPPLY (M2) AND FOOD PRICE INDEX (FPI)

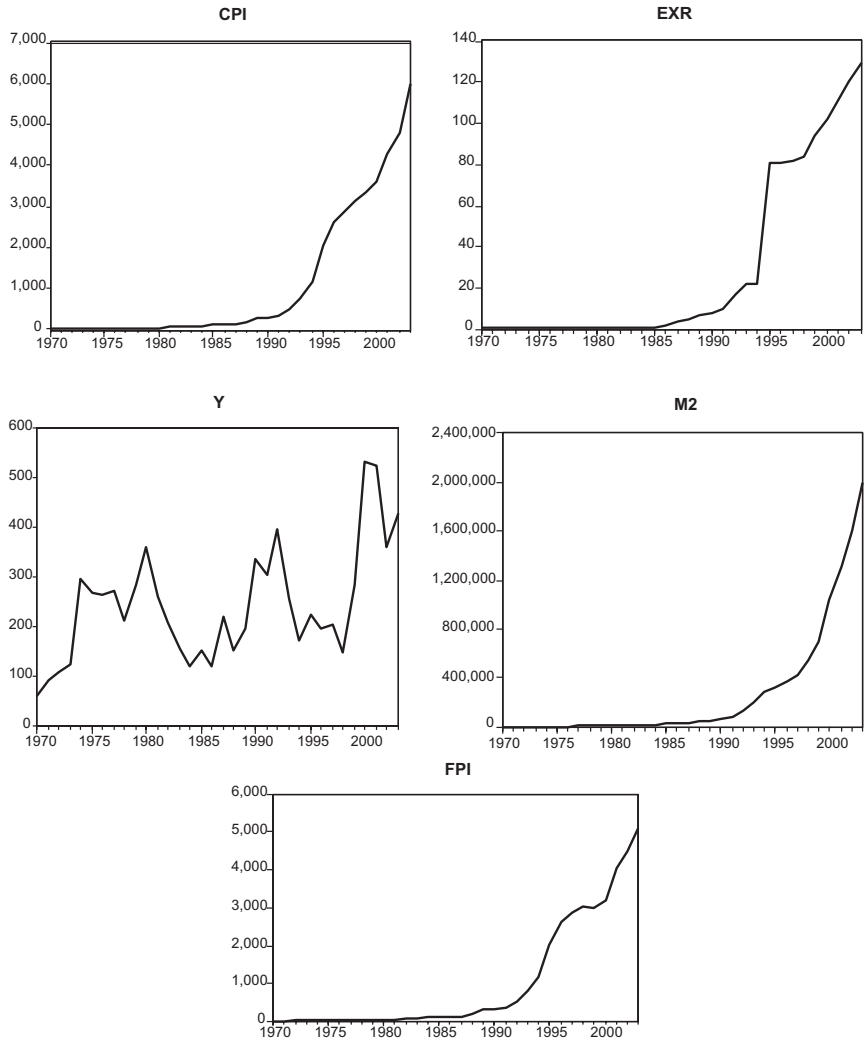


Table 1a.

NIGERIA: VISIBLE TRADE

Sector	1970	1996	1998	2000	2002	2004	2006
Oil	32.9%	77.3%	67.3%	72.9%	64.6%	68.1%	96.7%
Non-Oil	67.1%	22.7%	32.7%	27.1%	35.4%	31.9%	3.3%

Sources: Central Bank of Nigeria: *Changing Structure of the Nigerian Economy (2000)*
Central Bank of Nigeria: *Annual Report and Statement of Accounts (2002 and 2006).*

Table 1b.

SELECTED MACROECONOMIC AND SOCIAL INDICATORS

Indicator	2002	2003	2004	2005	2006
GDP at Current Market Prices (₦' billion)	7,984.4	10,136.4	11,673.6	14,894.5	18,222.8
Manufacturing Capacity Utilisation (%)	54.9	56.5	55.7	54.8	53.3
Inflation Rate (%) (12-month moving average)	12.9	14.0	15.0	17.9	8.2
Narrow Money (M1) %	15.9	29.5	8.6	15.5	15.4
Broad Money (M2) %	21.6	25.0	12.3	16.6	30.6
Net Credit to Government	6320.6	58.4	-17.9	-37.0	-676.2
Credit to Private Sector	19.7	26.8	26.6	30.8	28.2
Average Crude Oil Price (US$/ barrel)	25.0	29.2	38.7	55.4	66.4
End of Period AFEM/DAS Rate (₦/$1.00)	126.9	137.0	132.9	130.3	128.3
Average Bureau de Change Exchange Rate (₦ /$)	137.8	142.0	140.8	142.6	137.1
End of Period Bureau de Change Exchange Rate (₦/$)	138.6	150.4	138.7	141.5	129.5
GDP per Capital (₦)	65,232.2	80,320.1	89,866.1	111,569.3	132,017.9
GDP per Capital (US$)	839.1	620.9	673.2	847.4	1,036.2
Population (million)	122.4	126.2	129.9	133.5	140.0
Population Growth Rate (%)	2.8	2.8	2.8	2.8	4.9
Adult Literacy Rate (%)	57.0	57.0	62.0	57.0	64.2
Incidence of Poverty	***	***	54.4	54.4	54.0

Source: Central Bank of Nigeria: Annual Report and Statement of Accounts (2006).

IV. Model Specification and Data Sources

4.1. Model Specification

It is conventional in the literature to specify traditional models of inflation based on the structuralist and monetarist (Taylor, 1991; Balaksihhnan, 1994, Orubu, 1995; Omotor, 2005a) claims. In the structuralist model, inflation is attributed to sectoral disequilibria due to slow growth of agriculture and weak external balance, while the monetarist model specifies inflation as functionally determined by excess money supply growth over real output growth. The Nigerian economy as discussed in the previous section exhibits both characteristics. Consequent upon this, the study adopts an approach in which the two models are hybridized.

The empirical model applied in this paper follows the lead by Barungi (1997) and modified by adopting the general-to-specific methodology (Hendry, 1995) which selects only variables that are most closely related to exchange rate and inflation. As such, the following specification of the VAR which reveals both simultaneity and interaction among the variables can be stated as:

$$(P_t, M_t, y_t, E_t) \qquad 1.$$

where, P_t, is the price level, M_t is money supply, y_t is output level and E_t is the exchange rate. The working of the simple model is based on the clarity of economic theory and research on domestic inflation. Monetary growth relative to inadequate real output growth causes inflation. International inflation is transmitted through imported goods and exchange rate movements.

4.2. Data and Data Sources

Annual values of real output, money supply (broad), prices (consumer price index), and official exchange rate are used in the paper. The period of study is 1970-2003. Data for the variables were obtained from the Central Bank of Nigeria: *Statistical Bulletin* (various issues) and the *International Financial Statistics* of the International Monetary Fund CD-ROM, 2007.

All the variables are expressed in nominal values and measured at log difference of their actual levels except otherwise stated. The time series properties of the data were evaluated since inferences drawn from VARs may be sensitive to trend specification (Odusola and Akinlo, 2001).

V. Time Series Properties, Results and Discussions

5.1. Time Series Properties

This study adopted two unit root tests; the Augmented Dickey-Fuller (ADF) and the Phillips-Peron (PP). From the unit root tests, the results presented in Table 2, show that all the variables though non-stationary at levels, are stationary at first-order difference and as such, do not have two-unit roots[2]. Since all the series are integrated of the same order (1), the series can be tested for the existence of a long-run relationship (cointegration).

Table 2.

UNIT ROOT TESTS FOR THE VARIABLE USED IN THE MODELS

Levels						
Variables	ADF Test Statistic	Order of Integration	Included in Test Equation	Phillips Person Test	Order of Integration	Included in Test Equation
LCPI	0.1950	/(1)	T & C	0.8134	/(1)	T & C
LEXR	0.6372	/(1)	T & C	0.4213	/(1)	T & C
LM2	0.11472	/(1)	T & C	0.0390	/(1)	T & C
LY	-1.4750	/(1)	C	-1.8837	/(1)	T & C
LFPI	-0.0416	/(1)	T & C	0.0909	/(1)	T & C

First Differences						
Variables	ADF Test Statistic	Order of Integration	Included in Test Equation	Phillips Person Test	Order of Integration	Included in Test Equation
LCPI	-3.1833	/(O)	T & C	-2.9426*	/(O)	T & C
LEXR	-4.8531	/(O)	T & C	-5.0557	/(O)	T & C
LM2	-3.7127	/(O)	T & C	-3.6192	/(O)	T & C
LY	-3.6325	/(O)	C	-3.7064	/(O)	C
LFPI	-4.4489	/(O)	T & C	-3.40969	/(O)	T & C

Note: C = intercept; T & C = Trend and Intercept

Source: Author's computation

[2] Todd (1990) and Ohanian (1988) have discussed this in details.

5.2. Cointegration

In the literature, the finding that many macro time variables may contain unit root spurred the development of non-stationary time series analysis; given that using non-stationary variables in a model may lead to spurious regressions. However, Engle and Granger (1987) pointed out that if a linear combination of such non-stationary series are stationary, or *I(0)*, then the non-stationary (with a unit root), time series are said to be *cointegrated*. In other words, a vector of time series is said to be cointegrated with cointegrating vector if each element is stationary only after differencing while linear combinations are themselves stationary. This stationary linear combination is called the cointegrating equation and may be interpreted as a log-run equilibrium relationship between the variables. In the preceding sub-section, the unit root tests revealed that the variables of interest in this study are non-stationary at levels and are such a VAR-based cointegration test is required.

Table 3.

JOHANSEN TEST FOR COINTEGRATION VECTORS: LCPI, LEXR, LM_2, LY

Hypotheses	Max Eigen Statistic ($\square_{max}$)	Critical Values (95%)	Trace Statistic ($\square_{trace}$)	Critical Values (95%)
r ≤ r > 0	29.33737 (0.0295)	27.58434	49.5290 (0.0345)	47.85613
r ≤ 1 r > 1	12.7562 (0.4749)	21.13162	20.19163 (0.4099)	29.79707
r ≤ 2 r > 2	7.417473 (0.4410)	14.2646	7.435434 (0.5276)	15.49471
r ≤ 3 r > 3	0.017961 (0.8933)	3.841466	0.017961 (0.8933)	3.841466

Note: *Number of cointegrating vectors: 1. Figures in parentheses are probability values (MacKinnon-Haug-Michelis, 1999 p-values.*

The Johansen (1991, 1995) cointegration test[3] was undertaken for the model in equation 1 with a lag of one since annual series were adopted. Variables that

[3] VAR-based cointegration test was implemented using EViews ver.6 software package.

entered the substantive VAR were money, price, output and exchange rate. The results are reported in Table 3. The maximum eigenvalues as well as the trace statistics from the unrestricted VAR suggest the presence of only one cointegrating vector and no evidence exists for more than one. The fact that the variables are cointegrated supports the use of a vector error correction (VEC). The VEC specification according to Lilien, Sueyoshi, Ellsworth, Kawakatsu, Startz, Wilkins, Nor and Engle (1998), though allows a wide range of short-run dynamics, restricts the long-run behaviour of the endogenous variables to converge to their cointegration relationships; and the cointegration term is referred to as the *error correction term*.

Normalising variable LCPI, the long-run cointegration relationship is presented in equation (2); with the asymptotic standard errors reported in parentheses. It is clear that growth of money supply and output have dominant long-run effects on inflation than exchange rate. This result seems consistent with the fact that increased money supply offers stronger explanation of inflation; while exchange rate played a relatively weak role. For instance, 100 per cent depreciation induces a 32 per cent effect on inflation; while a 100 per cent increase in money supply induces 68 per cent increase in inflation, all things being equal. The long-run effects of these variables with their standard error values reported in parentheses are also statistically significant at 5 percent level.

$$\text{LCPI} = 0.3213\text{LEXR} + 0.6802\text{LM2} + -0.4272\text{LY} \qquad (2)$$
$$(0.0239) \qquad (0.0262) \qquad (0.0566)$$

Table 4.

RESIDUAL CORRELATION MATRIX OF REDUCED-FORM

Variables	LCPI	LM2	LEXR	LY
LCPI	1.000000	0.013546	0.393589	-0.405910
LEXR	0	-0.133664	1.000000	0.049444
LM2	0	1.000000	0	0.521008
LY	0	0	0	1.000000

The summary of the residual correlation matrix is presented in Table 4. The correlation matrix seems to imply an inverse relationship between output and prices as well as a positive relationship between money and prices. The contractionary impact of devaluation on money supply as well as the expansionary impact of devaluation on inflation is also acknowledged by the reduced-form errors of the correlation matrix.

We also re-examined the effects of the exchange rate on inflation by capturing the effects of sectoral disequilibria that constitute the centre of the structuralist model of inflation. In the literature, the structuralist model of inflation customarily specifies food bottleneck as a major determinant. Food bottleneck proxied by food price index (FPI) is thus incorporated as a basic argument. The food price index is obtained from the Central Bank of Nigeria *Statistical Bulletin (2006)*. In Nigeria's case the argument for introducing price of food is typical given that the teeming Nigerian population is unable to produce enough to meet the increasing food demand growth. Food prices are also the largest weight in calculating the consumer price index (CPI) in Nigeria. Consequently, the system was re-formulated to accommodate both monetarist and structuralist claims on the causes of inflation. Table 5 reports the results of the Johansen test. The test outcome indicates that the Maximum Eigenvalue and Trace statistics strongly reject the null hypothesis of no cointegration in favour of at least one cointegrating relationship.

The implied long-run solution to the inflation equation with standard error values reported in parentheses is:

$$LCPI = 0.55LEXR + 1.03LM2 - 0.60LY - 0.588LFPI \quad (3)$$

$$(0.08) \qquad (0.14) \qquad (0.09) \qquad (0.225)$$

Table 5.

JOHANSEN TEST FOR COINTEGRATION VECTORS
(LCPI, LEXR, LM_2, LY, LFPI)

Hypotheses	Max Eigenvalue ($\square_{max}$)	Critical Values (95%)	Trace ($\square_{trace}$)	Critical Values (95%)
$r \leq 0$ $r > 0$	36.3176 (0.0251)	33.8768	70.5012 (0.0441)	69.8188
$r \leq 1$ $r > 1$	14.8984 (0.7562)	27.5843	34.1836 (0.4918)	47.8561
$r \leq 2$ $r > 2$	8.7447 (0.8383)	21.1316	19.2852 (0.4726)	29.797
$r \leq 3$ $r > 3$	7.4474 (0.4376)	14.2646	10.3587 (0.2541)	15.4947
$R \leq 4$ $r > 4$	2.91128 (0.088)	3.841466	2.91128 (0.088)	3.841466

Note: *Number of cointegrating vectors: 1. Figures in parentheses are probability values (MacKinnon-Haug-Michelis, 1999 p-values) automatically generated by the EViews version 6. software.*

This indicates a significant long-run effect of price of food and exchange rate on inflation. A 100 per cent devaluation of the exchange rate might induce a 55 per cent increase in inflation all things being equal. While a 100 per cent increase in the price of food seems to increase inflation by 58 per cent *ceteris paribus*. This implies a food scarcity crisis in Nigeria. Although it may not be appropriate to compare the findings in equation (3) with that of equation (2), the results relative to the money supply variable, reveal a sharp agreement. The money supply variable induces a more than proportionate change on inflation.

5.3. The Vector Error Correction (VEC) Model

Since the variables are non-stationary in levels and the Max-eigenvalue test indicates 1 cointegrating equation at 0.05 level, their dynamic relationship as earlier noted must be specified by error correction representation in order to capture both the short-run and long-run relationships. Consequently, we estimated the VEC model that includes one lag of all the variables (endogenous and exogenous) on the current values of the endogenous variable (LCPI). The result in its parsimonious state is presented in Table 6.

Table 6.

Error Correction Results of LCPI

Regressor	**Coefficient**	**t-values**
Intercept	0.0098	0.585
⌂LCPI(-1)	0.2986	1.9936
⌂LEXR(-1)	-0.1486	-2.1696
⌂LM2(-1)	0.2808	1.7612
⌂LY(-1)	0.1564	2.6874
ECM(-1)	-0.9763	-4.7113

Adjusted R^2 = 0.595 **Standard Error = 0.14615** **F- statistic = 9.79977**

VEC Residual Serial Correlation LM test = 22.235 (0.1361)* **** prob. value***

Table 6 presents the results of the ECM abridged from the general VEC estimates. The estimated specification for the inflationary consequence suggests that the speed of adjustment (the error-correction mechanism) to long-run equilibrium is high. Specifically, over ninety-seven percent (97.63%) of the disequilibrium

errors, which occurred the previous year, are corrected in the current year. This persistence suggests the existence of strong inflation inertia.

As shown in Table 6, the lagged values of LCPI positively and significantly influenced the behaviour of current inflation. In addition, the exchange rate variable lagged by one period had a significant negative effect on inflation. This may imply that the impact of past exchange rate behaviour on current inflation dies-off very rapidly and is not significantly transmitted into future behaviour of inflationary trend. Another implication of this result is that currency depreciation (the naira) fuels inflation as evident in the significant degree of pass through.

The one period lag of broad money supply (LM2(-1)) exerted a positive and statistically significant influence on the current level of inflation thus confirming the long held view that money supply affects the price level with a lag. It is however found that the coefficient of output represented by real GDP lagged by one period is wrongly signed. This finding corroborates Egwaikhide, Chete and Falokun (1994) and Odusola and Akinlo (2001) studies. Comparatively, it may be argued with caution that monetary actions in Nigeria may imply to impact more on inflation than fiscal actions. This may not be too disturbing because fiscal dominance (deficit) that characterizes the Nigerian economy is in actual sense expended in form of money.

The Adjusted R-square of the error correction model shows that about 60 percent of the variation in dependent variable (LCPI) is explained by the combined effects of all the determinants. The F-statistic (9.8) shows that the overall regression is significant while the residual test for serial correlation using the LM test indicates absence of autocorrelation. The equation standard error of 0.15 signifies that in about two-thirds of the time, the predicted value of inflation (LCPI) would be within 14.62 percent of the actual value.

The VEC estimate of the food price augmented model was also analysed. However, the model failed the battery of diagnostic tests (autocorrelation, multicollinearity and Jacque-Bera normality tests). Consequent upon this, the VEC estimates of this model were dropped. The next sub-section presents tabular and graphical display of the impulse response functions.

5.4. Impulse Response Functions

Table 7 and Figure 2 depict the impulse response to Cholesky One Standard Deviation Innovations for the functions of the variables, using a horizon of 10 periods. The responses are for a particular variable to a one-time shock in each of the variables in the system. As noted by Odusola and Akinlo (2001), the interpreta-

tion of the impulse response functions takes into consideration the first differencing of the variables as well as the vector error correction estimates. The findings of the impulse response functions can be summarized as follows:

(a) the responses of inflation to official exchange rate and money supply shocks were consistently positive particularly from the third period. The response of inflation due to exchange rate (depreciation) shock is consistent with the findings of Chete and Falokun (1994), Ajakaiye and Ojowu (1994) and Odusola and Akinlo (2001). The results imply that there are short-run effects of devaluation on price inflation though not contemporaneously, the effects will last for sometime, but more in the third and fourth (medium) periods. In the case of price inflation response to innovations in money supply, the effects were more in the second and third periods and thereafter; though not proportionately, in the seventh and eight periods.

(b) the responses of inflation due to output shocks were consistently negative. Output decline explains 5.4 per cent of the forecast error variance of inflation in the second period and between 8 percent and 6 percent on the average thereafter (Table 7) till the eighth period. As regards other responses, exchange rate changes negatively respond to changes in money supply and output level. Generally speaking, the change in inflation response to changes in exchange rate, money supply and output level stabilizes in the long-run from the fifth period.

5.5. Variance Decomposition Results

The forecast variance decomposition provides complementary information on the dynamic behaviour of the variables in the system. The forecast error variance decomposes the forecast variance into the contributions by each of the different shocks. Table 8 and Figure 3 report the fraction of the forecast error variance for each variable that is attributable to its own innovations and to innovations in other variable. From Table 8, "own shocks" constitute a significant source of variation in price inflation (LCPI) forecast errors in the short-run, declining from 100 percent in the first period to 59 per cent over a 10 period horizon. The findings also denote that money supply constitutes a predominant source of inflation by the long-run. Specifically, money supply (LM2) by period ten explains over 32 per cent of price inflation while output level (LY) and exchange rate devaluation (LEXR) account for a paltry 4.74 and 4.17 per cent sources of price inflation by period 10. Thus, money supply, and exchange rate devaluation though fuelled inflation more in the long-run, the impact of money supply changes is more. Output level, whose impact on inflation was more in the short-un, impacted less on inflation than other factors. The variance decompositions of other variables are also reported in Table 8.

Table 7.

IMPULSE RESPONSE TO CHOLESKY ONE S.D. INNOVATIONS

Response of DLCPI				
Period	DLCPI	DLEXR	DLM2	DLY
1	0.093057	0	0	0
2	0.0786	-0.0106	0.073197	-0.05401
3	0.064138	0.038744	0.061257	-0.0895
4	0.051241	0.027316	0.028514	-0.07085
5	0.061465	0.014714	0.027995	-0.03717
6	0.069609	0.007034	0.039928	-0.04147
7	0.0681	0.01617	0.048773	-0.06067
8	0.061764	0.022083	0.04306	-0.06517
9	0.061052	0.019414	0.036263	-0.05539
10	0.064281	0.014696	0.037342	-0.04941

Source: Author's calculation

Response of DLEXR:				
Period	DLCPI	DLEXR	DLM2	DLY
1	0.161883	0.339313	0	0
2	0.081044	0.172551	-0.05257	-0.04484
3	0.11502	0.252433	-0.01604	0.004379
4	0.103657	0.205687	-0.04074	-0.00341
5	0.114511	0.22487	-0.02112	-0.00709
6	0.106772	0.221929	-0.02513	-0.0152
7	0.107123	0.226051	-0.02846	-0.01213
8	0.107204	0.221601	-0.03006	-0.0074
9	0.109148	0.2214	-0.02781	-0.00711
10	0.108806	0.222044	-0.02656	-0.01014

Source: Author's calculation

Response of DLM2:				
Period	DLCPI	DLEXR	DLM2	DLY
1	-0.00952	-0.03724	0.137395	0
2	-0.01872	0.011866	0.131942	0.002836
3	-0.02244	-0.00661	0.098337	-0.00731
4	-0.01846	-0.0061	0.111115	0.011093
5	-0.01653	-0.01023	0.110748	0.010494
6	-0.01584	-0.00744	0.114348	0.002876
7	-0.01847	-0.00498	0.113556	0.000919
8	-0.01891	-0.00552	0.110498	0.004039
9	-0.01782	-0.00742	0.110635	0.006526
10	-0.01711	-0.0075	0.112262	0.005545

Source: Author's calculation

Response of DLY:				
Period	DLCPI	DLEXR	DLM2	DLY
1	-0.14314	0.205923	0.243118	0.28061
2	-0.09928	0.146463	-0.04463	0.117106
3	-0.10359	0.144275	0.075106	0.139038
4	-0.11335	0.162738	0.056123	0.161521
5	-0.10621	0.146736	0.038579	0.153978
6	-0.10495	0.14971	0.055919	0.156259
7	-0.10686	0.152461	0.052721	0.151141
8	-0.10767	0.152816	0.050555	0.150603
9	-0.10767	0.151904	0.050152	0.15395
10	-0.10675	0.150939	0.050425	0.154618

Source: Author's calculation

Figure 2.

IMPULSE RESPONSE FUNCTIONS

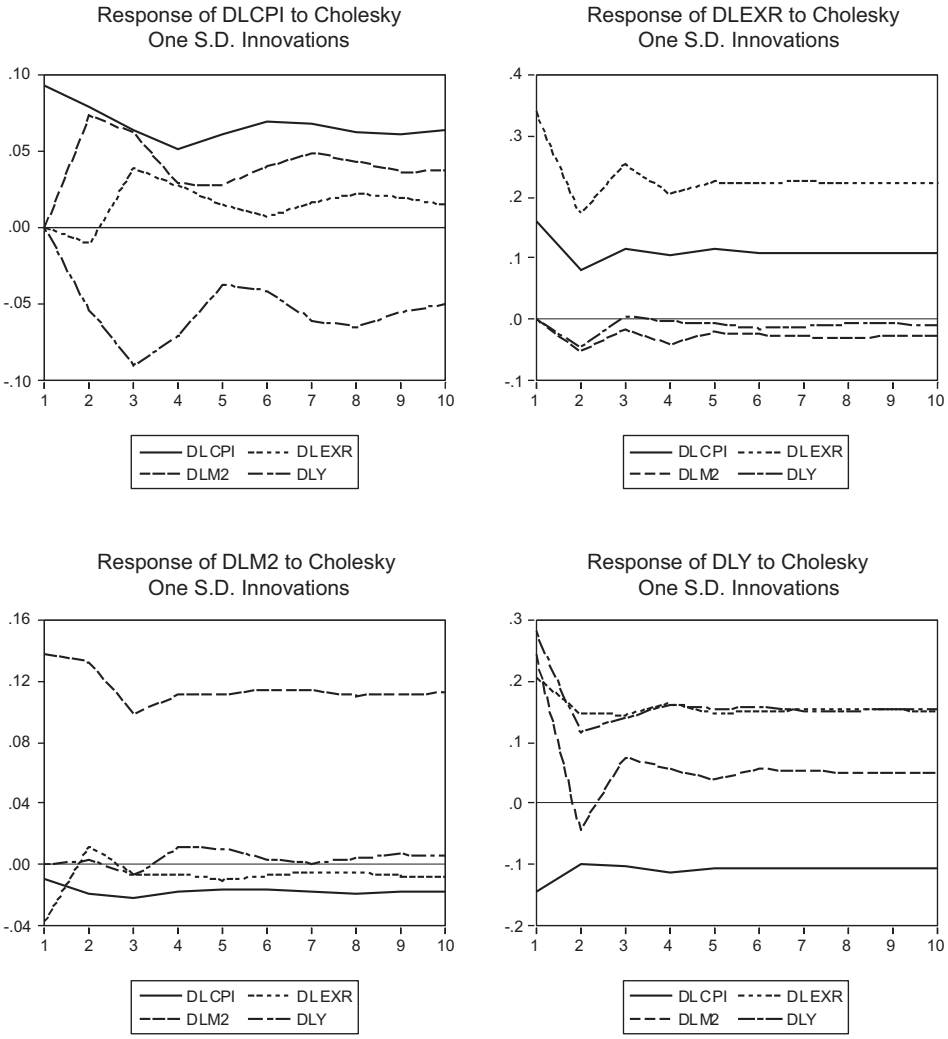


Table 8.

VARIANCE DECOMPOSITION OF INFLATION AND OTHER VARIABLES

Variance Decomposition of DLCPI:

Period	S.E.	DLCPI	DLEXR	DLM2	DLY
1	0.1042	100	0	0	0
2	0.1303	75.4814	1.6816	17.6365	5.2005
3	0.1446	61.4366	4.0339	30.2536	4.276
4	0.1477	59.1422	4.6867	32.0255	4.1456
5	0.1479	59.1271	4.7296	31.9709	4.1725
6	0.148	59.0915	4.7269	32.0059	4.1757
7	0.1481	59.0459	4.7338	32.0476	4.1727
8	0.1481	59.036	4.7366	32.0553	4.1721
9	0.1481	59.0359	4.7368	32.0551	4.1722
10	0.1481	59.0358	4.7368	32.0553	4.1722

Variance Decomposition of DLM2:

Period	S.E.	DLCPI	DLEXR	DLM2	DLY
1	0.1165	1.55E-05	6.0451	93.955	0
2	0.1369	1.05921	7.0052	90.155	1.7806
3	0.1381	1.86772	7.1785	88.984	1.9698
4	0.1385	2.0396	7.1511	88.807	2.0019
5	0.1387	2.0385	7.1699	88.795	1.9967
6	0.1388	2.0398	7.1801	88.785	1.9956
7	0.1388	2.04311	7.181	88.78	1.9962
8	0.1388	2.04387	7.1809	88.779	1.9964
9	0.1388	2.04387	7.181	88.779	1.9963
10	0.1388	2.04388	7.181	88.779	1.9963

Variance Decomposition of DLEXR:

Period	S.E.	DLCPI	DLEXR	DLM2	DLY
1	0.3044	14.2012	85.799	0	0
2	0.3164	14.4949	79.899	0.6813	4.925
3	0.3182	14.3724	79.182	1.53954	4.906
4	0.3188	14.3318	78.979	1.79831	4.8905
5	0.3188	14.3396	78.959	1.8102	4.8915
6	0.3188	14.342	78.953	1.81286	4.8919
7	0.3188	14.3414	78.95	1.81724	4.8917
8	0.3188	14.3412	78.949	1.81842	4.8916
9	0.3188	14.3412	78.949	1.81848	4.8916
10	0.3188	14.3412	78.949	1.81849	4.8916

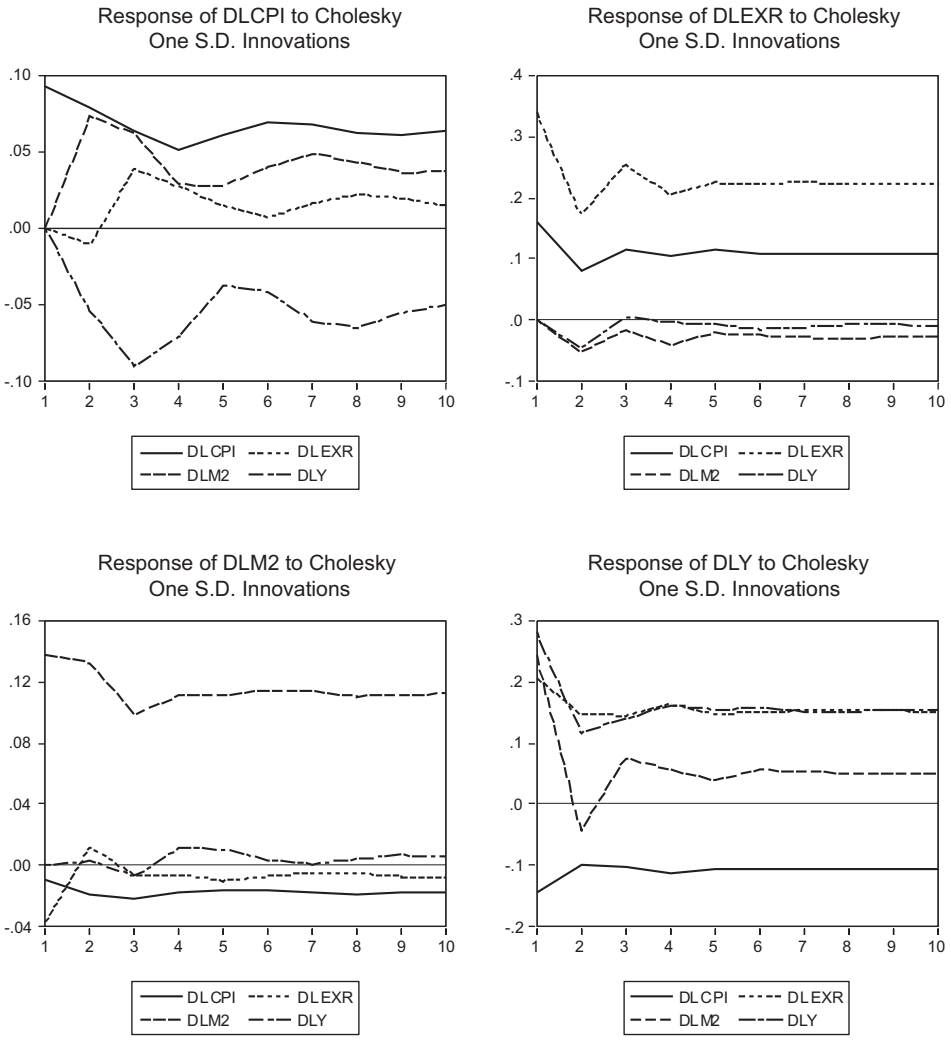
Variance Decomposition of DLY:

Period	S.E.	DLCPI	DLEXR	DLM2	DLY
1	0.3603	4.61352	7.8246	33.046	54.516
2	0.3707	4.6593	7.6068	36.221	51.513
3	0.3738	4.58649	7.7431	37.006	50.665
4	0.3743	4.61587	7.7745	37.055	50.555
5	0.3743	4.63148	7.7736	37.048	50.547
6	0.3743	4.6324	7.7736	37.055	50.539
7	0.3744	4.63209	7.7743	37.058	50.535
8	0.3744	4.63221	7.7744	37.059	50.535
9	0.3744	4.63228	7.7744	37.059	50.535
10	0.3744	4.63228	7.7744	37.059	50.535

Source: Author's Computations

Figure 3.

VARIANCE DECOMPOSITION OF VARIABLES



5.6. The Slope-Dummy Method

The slope-dummy technique is a simple measure of impact assessment. This augmented equation is based on the assumption that key policy measures can be assessed through the differential impacts of the naira exchange rate and price in-

flation. Arguments in support of the exchange rate as a vital policy instrument and the articulation of the slope dummy procedure can be found in Orubu, (1996) and Omotor and Jike (2005).

The results of the slope-dummy equation reported in Table 9 indicate no statistical significance with evidence that price inflation did not reduce significantly during the period of reforms. The implication of this is that exchange rate policy since the period of reforms has been impotent in exerting significant influence on price inflation. This may have explained the several exchange rate policy reversals since the 1990s and a support of the allegation that Nigerian commercial banks before the 2005 banking consolidation exercise were involved in round-tripping of foreign exchange.

Table 9.

SLOPE DUMMY EQUATION

Dependent Variable: DLCPI		
Variable	Coefficient	t-Statistic
DLEXR	0.0036	0.0072
DUMDLEXR	0.1156	0.2319
Constant	0.1762	4.065

Adjusted R-Squared: 0.24 *Sum squared resid.: 0.446* *F-statistic: 4.2632 (0.0133)*
Durbin-Watson Stat.: 1.552 *( ) is p-value*

5.7. Granger Causality Test

Variables used in the VEC analysis were further subjected to test of causality in order to determine the likely feedback effects that exist among them given that they are cointegrated. The summary result using Granger test for causality (as presented in Table 10) revealed that exchange rate, money supply and output appear to Granger-cause inflation unidirectionally. Despite this, Granger causality tests suffer from two significant limitations as revealed by Masih and Masih (1995). The first is their inability to indicate the direction of response in terms of whether they are negative or positive. The second is related to their interpretation being within-sample tests, thus providing little evidence on the dynamic properties of the system (Giorgioni and Holden, 2001). These associated problems have been handled by the analyses of the impulse response functions (see Table 7 and Figure 2).

Table 10.

VEC GRANGER CAUSALITY (LAG = 2)

Dependent Variable	LCPI	LEXR	LM2	LY	df
LCPI	←	[0.685]	[0.591]	[0.600]	1
LEXR	[0.0301]**	←	[0.529]	[0.3914]	1
LM2	[0.0792]*	[0.749]	←	[0.0285]*	1
LY	[0.0072]**	[0.6782]	[0.3695]	←	1
ALL	[0.000]**	[0.865]	[0.169]	[0.1508]	3

[ ]: level of significance of Wald test **significant at 5% *significant at 10%

6. Concluding Remarks

The paper examined the impact of price response to exchange rate changes in Nigeria, and how the policy shift during the reform period impacted on inflation via exchange rate; using data from 1970 to 2003 inclusive. Both the vector error correction (VEC) model (was estimated) and slope-dummy methodology was adopted in order to determine the economic and statistical significance of government policy shift (exchange rate reform) on inflation. Evidence from the paper revealed that exchange rate and money supply aggravated inflation in Nigeria. The impulse response functions exerted an expansionary impact on the exchange rate depreciation on inflation more in the long-run while stabilizing, in both the medium and short-run. The opposite was however the case (contractionary) with the slow output expansion. These may suggest that exchange rate liberalization (flexible exchange rate system) does not necessarily reduce inflation, particularly in the short-run (as earlier argued by Singh, 1986). The influence of money supply on price stability appears to be overwhelming relative to other variables in the model. The lack of output expansion, exchange rate round-tripping, fraudulent foreign exchange transfers and government poor fiscal discipline may have accounted for the impotence of exchange rate policy reform and reversals since 1986.

Evidence from the forecast error variance decomposition suggests that past levels of inflation, money supply and exchange rate exerted much stronger dynamic effects on inflation forecast errors. Moreover, the slope-dummy results further confirm the impotence of exchange rate flexibility on inflation since the reform period. This may probably be due to the constraints earlier mentioned.

The above findings invoke the following policy recommendations:

(a) money affects inflation with a lag. Thus the design of monetary policy should take this into cognisance in monitoring and targeting;

(b) exchange rate depreciation can be inflationary; a stable and consistent monetary cum exchange rate policy stance in order to stem inflation is advocated. This craves support with some caution for inflation targeting by the Central Bank of Nigeria, although, this is outside the empirical validation of this paper;

(c) sustenance of stringent regulations by the monetary authorities (Central Bank of Nigeria) to check fraudulent transfers of public foreign exchange and round-tripping by commercial banks; and

(d) policies that will encourage domestic output expansion are needed to feed the ever-growing food demand in Nigeria.

One limitation of this paper is its inability to incorporate some other important determinants of inflation such as parallel exchange rate and lending rate. This is another window for further research.

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REFORMA POLITIKE DEVIZNOG TEČAJA I NJENE POSLJEDICE NA INFLACIJU: SLUČAJ NIGERIJE

Sažetak

Ovaj rad istražuje utjecaj promjene deviznog tečaja na promjene cijena u Nigeriji, uz korištenje godišnjih podataka za razdoblje 1970.-2003. Ocijenjeni su vektorski model s korekcijom odstupanja (VEC model) i slope-dummy model, kako bi se odredio utjecaj promjena vladine politike (reforma politike deviznog tečaja) na inflaciju. Rezultati istraživanja ukazuju na važnost politike reforme deviznog tečaja za inflaciju u Nigeriji. Rezultati dekompozicije varijance prognostičke greške daju naslutiti da su ponuda novca i devizni tečaj izvršili jači dinamički utjecaj na prognostičku grešku inflacije nego nivo proizvodnje. Međutim, rezultati primjene slope-dummy metodologije potvrdili su slab utjecaj politike fleksibilnog deviznog tečaja na inflaciju. Članak između ostalog ističe da je za stabilnost cijena potrebna stabilna, konzistentna i komplementarna politika ponude novca i deviznog tečaja, dok je ekspanzija domaće proizvodnje (osobito poljoprivredne) potrebna za podmirivanje stalno rastuće potražnje za hranom u Nigeriji.

Ključne riječi: Nigerija, devizni tečaj, inflacija, ponuda novca, slope-dummy, VEC model