NOVEMBER 1994

RESEARCH PAPER TWENTY-SIX

EXCHANGE RATE DEPRECIATION, BUDGET DEFICIT AND INFLATION – THE NIGERIAN EXPERIENCE

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Exchange rate depreciation, budget deficit and inflation — the Nigerian experience

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AERC Research Paper 26
African Economic Research Consortium, Nairobi
November 1994

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Typeset by Centre for the Study of African Economies,
University of Oxford,
St Cross Building, Manor Road,
Oxford, OX1 3UL,
England.

for the African Economic Research Consortium,
P.O. Box 62882, Nairobi, Kenya.

Printed by The Regal Press Kenya Ltd.,
P.O. Box 46166,
Nairobi, Kenya.

ISBN 9966-900-13-6

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Acknowledgements

The execution of this empirical enquiry has benefited from the valuable comments and suggestions of the participants and resource persons at the various workshops organised by the AERC, especially between December 1990 and May 1992. In particular, Benno J. Ndulu's initial reactions to the proposal for this research, together with the technical assistance of Mohsin S. Khan and Christopher S. Adam helped to improve every section of this study and we are happy to acknowledge it here.

We are also thankful to Olu D. Ajakaiye, Rasaq A. Olopoenia, Mufutau I. Raheem and Fidelis O. Ogwumike, for helpful comments and suggestions. However, the views expressed are those of the authors and do not necessarily represent those of the AERC and NISER.

I Introduction

One of the thorniest issues in Nigeria's policy arena today is how to put inflation under effective control. The control of inflation has been central to both monetary and fiscal policy in the last few years, as demonstrated in the various budgets and policy statements. Historically, the origin of the current inflation dates back to the 1970s, when the revenue accruing to the government from the non-renewable oil resource rose steeply. With the increase in public expenditure, enhanced by oil revenues, there was vast expansion in aggregate demand. With the inelastic supply of domestic output, inflation inevitably resulted. The rapid growth in money supply, as a result of the monetisation of the earnings from oil, also exerted upward pressure on the general price level.

The price of crude oil slumped in the world market during the first half of the 1980s. Thus, Nigeria's crude oil, which sold at slightly above US$41 a barrel in early 1981, fell precipitously to less than US$9 by August 1986. This triggered a series of developments in the economy. One example is the state's fiscal crisis, as reflected in the persistent and substantial budget deficit which cumulated to approximately N17.4 billion in the five years between 1980 and 1984. Monetary policy became highly expansionary as a large part of the deficits incurred during this period were financed through the creation of credit. Indeed, the total domestic credit to the economy recorded an average annual growth rate of 29.9% in 1980–84 and most of the increase was attributable to net claims by the government. Simultaneously, two-digit inflation at a mean yearly rate of 20.2% was registered, clear evidence, perhaps, in support of the monetarist proposition. But the inflation in 1984, which stood at almost 40%, is often explained in terms of acute shortages of imported goods and services imposed by inadequate foreign exchange earnings, a derivative of the steep fall in crude oil prices.

With the deepening internal and external disequilibria, it became imperative to adopt the Structural Adjustment Programme (SAP) from July 1986. The SAP, which is predicated mainly on the principle of 'getting prices right', has exchange rate reform as its central focus[1]. In pursuit of this, the Second-Tier Foreign Exchange Market (SFEM) was introduced in late September 1986 and since then the naira has depreciated sharply against the US dollar and other

major currencies. Quantitatively, the naira, which traded at N4.62:$1.00 at the inception of SFEM in late September 1986, had, by the end of 1989, exceeded N7.65:$1.00, a change of almost 65.6%. During the same period, inflation leapt from barely 5.0% to almost 41.0%.

This development shows that the depreciation of the naira has a role to play in Nigeria's recent inflationary process. Concomitant with this is the substantial budget deficit operated annually by the Federal Government in the last decade or so. Part of the budget deficit is financed through bank credit which directly affects the money base. This also exerts upward pressure on the general price level. All this suggests that there are many sources of the current inflation. While the channels through which exchange rate depreciation affects prices are well known, the extent to which this phenomenon engenders price inflation in Nigeria is still not well researched.

As part of the attempt to fill this lacuna, this study examines the quantitative effects of exchange rate depreciation on budget deficit and inflation in Nigeria. This is achieved in two stages. First, a structural model of the interaction between exchange rate, budget deficit, inflation, and government revenue and expenditure is constructed. In doing this, we are influenced by recent developments on cointegration and the error correction model. Second, a simulation experiment on the impact of exchange rate movements on the general price level and budget deficit, in particular, is conducted. Policy implications of the simulation exercise are then derived.

This report presents trends in the relationship between exchange rate, budget deficit and inflation. It is complemented by recent empirical literature on inflation. Thereafter, a conceptual link between the above macroeconomic variables is sketched. The macro model developed is rooted in some of the key linkages and reflects some of the indications from preliminary observations from trend analysis.

Estimates of the individual equation are presented and results discussed. This is followed by the solution of the entire model, using Theil's inequality coefficient and its decomposition to evaluate the model's performance. Finally, we present the policy simulation results and our concluding remarks.

II Proximate causes of inflation in Nigeria — some preliminary observations from trends and relationships

A proper understanding of the determinants of inflation in Nigeria requires adequate discussion of the movements of the relevant variables over time. In response to this, we shall focus mainly on trends in inflation, budget deficit, monetary growth, growth in real GDP and exchange rate movements in the period between 1970 and 1989.

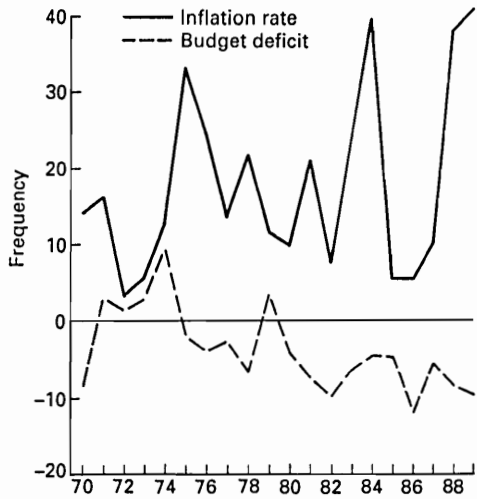
After the civil war in January 1970, there was a need to restructure the war-ravaged economy under the economic Second National Development Plan (1970–74). A major constraint confronting the government was the inadequacy of funds to execute the Plan's projects and programmes. Fortunately, the price of crude oil shot up in the world market due to the Middle East Crisis (1973–74). The average export price per barrel of Nigerian crude oil rose from a tiny level of US$4.13 in 1973 to US$14.74 in 1977 and to US$35.18 in 1980. Combined with this were various petroleum tax reforms at the start of the oil boom[2]. The aggregate effect of these was increased government revenue. Quantitatively, the federally collected revenue, which stood at N633.3 million in 1970, rose to N4.5 billion in 1974 and by 1980 had exceeded N15.0 billion.

Parallel to this was vast expansion in aggregate demand, led by growth of public expenditure. Indeed, in the decade 1973–83 the Keynesian public-expenditure-led growth (enhanced by oil revenues) was pursued by government. So it is not surprising that the Federal Government's outlay, which was approximately N839 million in 1970, leapt to N4.9 billion in 1975 and stood at over N14.0 billion by 1980. During this period, central government expenditure grew at a compound annual growth rate of 6.9%. While it is generally appreciated that the rise in public spending was to ensure that a large proportion of the population benefited from oil exploitation, this expenditure generated persistent budget deficits, as it exceeded revenues, in the second-half of the 1970s (except in 1979). Between 1975 and 1978, the cumulative budget deficit was about N4.8 billion. As a percentage of GDP, budget deficit fluctuated between 2 and 6.7% in the period. However, as

indicated in Figure 1, there seems to be no correlation between fiscal deficit and inflation.

In part, the budget deficits were financed from bank credit and the balance came from external loans[3]. Thus, monetary policy, like fiscal policy, was expansionary during the oil boom. Table 1 shows Nigeria's financial data for the period 1970 through 1989. The table demonstrates that there were increases in domestic credit in the economy, especially from 1976. It is almost incredible that the average annual growth rate of domestic credit stood at about 65% in 1976–80. In absolute terms, total domestic credit accelerated from N3.1 billion in 1976 to about N10.7 billion in 1980. Out of this, the share of net credit to the central government fluctuated between 20.2 and 40.8%.

Figure 1 Inflation rate and budget deficit



The growth of credit to government had two important direct effects. First, it vastly expanded aggregate demand and second, it accelerated the growth of domestic money supply. There was a rise in total imports as a result of the upsurge in aggregate demand that could not be met by the available supply in the economy. Available data shows that merchandise import registered an average annual growth rate of almost 23% in the five years from 1976–80. This was actually enhanced by the expansion in bank credit arising largely from fiscal deficit. Thus, the direct correspondence between budget deficit and the current account deficit is easily appreciated.

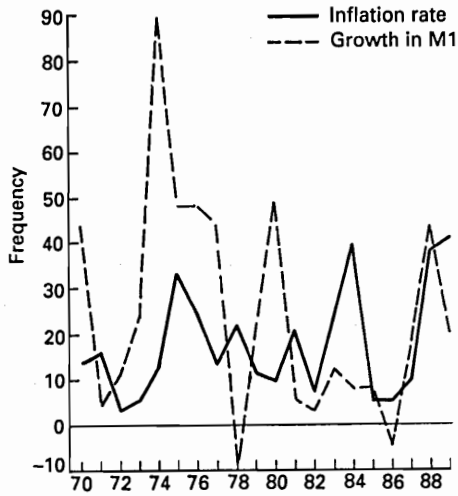
Table 1 Nigeria: Monetary survey 1970-89 (N million)

Year	Net foreign assets A	Domestic credit B	Credit to government Value N million C	Credit to government Percentage share (%) (C/B)	Credit to private sector Value N million	Credit to private sector Percentage share (%)
1970	154	1,141	666	58.4	475	41.6
1971	280	1,127	532	47.2	593	52.6
1972	244	1,274	518	40.7	749	58.8
1973	414	1,399	545	39.0	847	60.5
1974	3,500	-176	-1,310	744.3	1,121	-636.9
1975	3,668	1,161	-631	-54.3	1,750	150.7
1976	3,396	3,073	622	20.2	2,382	77.5
1977	2,962	6,010	2,452	40.8	3,459	57.6
1978	1,420	7,706	3,143	40.8	4,485	58.2
1979	3,228	8,662	3,313	38.2	5,126	59.2
1980	5,607	10,689	3,539	33.1	6,744	63.1
1981	2,556	15,746	6,299	40.0	8,917	56.6
1982	1,057	21,410	10,328	48.2	10,567	49.4
1983	808	27,590	15,465	56.1	11,071	40.1
1984	1,423	30,423	17,823	58.6	11,823	38.9
1985	1,816	31,900	18,297	57.4	12,822	40.2
1986	4,463	36,409	18,827	51.7	16,690	45.8
1987	6,865	40,209	21,157	52.6	17,918	44.6
1988	7,974	50,680	27,488	54.2	20,857	41.1
1989	20,044	36,337	6,879	18.9	25,832	71.1

Source: International Monetary Fund, *International Financial Statistics Year Book 1990.*

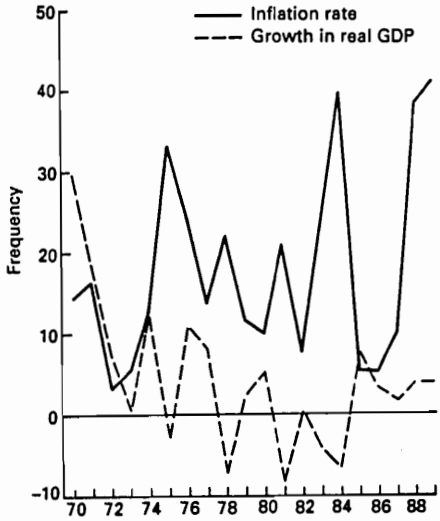
More important to the current discussion is the pressure which monetary expansion exerts on price inflation. Following the ebullient growth of domestic credit, it was not surprising that the mean annual growth rate of money supply (M1) stood at 33.7% during 1975–80. This would probably have been higher, but for the negative growth rate of 8.2% recorded in 1978. On average, the period of high monetary growth coincides with a high inflationary trend, as demonstrated by the growth of the consumer price index, even though price inflation generally declined from 33.3% to almost 10% between 1975 and 1980. This is summarized in Figure 2.

Figure 2 Inflation rate and growth in M1



In the 1970s, there does not seem to have been a strong contracyclical relationship, in line with theoretical expectation, between the growth of output, proxied by the annual growth of real GDP, and inflation (see Figure 3). Although real GDP recorded an impressive annual growth in 1970–72, double-digit inflation was registered in 1970–71 and inflation fell sharply to approximately 3.3% by 1972. Between 1974 and 1980, the expected relationship seems validated, though very weak. This tends to support the argument by Schatz (1984) that a sizeable proportion of the increase in aggregate demand was dissipated through inflation. The decline in Nigeria's other-than-oil GDP in the 1970s to the early 1980s possibly reinforces this argument[4].

Figure 3 Inflation rate and growth in real GDP



Between 1974 and 1980, the mean yearly growth rate of nominal exchange rate (official) was -2.5%. This is an indication that the naira appreciated against the US dollar during the period. Juxtaposed with this was a high rate of inflation which stood at 18.2%. A statement on the type of exchange rate regime adopted during the period under review may provide a useful insight into the observed relationship[5]. The local currency was fixed against the US dollar up to 1970, and in December 1971 the Nigerian pound was tied to the dollar. But a system of independent exchange rates (i.e., the naira exchange rate was independently fixed against the US dollar and the UK pound sterling) was pursued from 1974, although in practice the dollar/sterling cross rates actually determined the naira exchange rate against the US and UK currencies.

From February 1978, the naira exchange rate was based on a basket of currencies of Nigeria's major trading partners (UK, France, Japan, the Netherlands, Switzerland, the US and the former West Germany). One point is probably obvious from this sketchy presentation of Nigeria's exchange rate regime: the exchange rate policy was not employed as a principal instrument of economic management in Nigeria until the mid-1970s. The refusal to adopt an exchange rate policy to correct Nigeria's balance of payments difficulties of the 1960s is a graphic manifestation of this. Thus, exchange rate movements bear little relationship to inflation, as shown in Figure 4.

With respect to the parallel market exchange rate, the story seems to be quite different. While the mean growth rate of official exchange revealed that it appreciated in 1976–80, the parallel rate depreciated annually by 1.9%, on average, over the same period. Despite this, the yearly growth of consumer

price index prior to 1981 seems not to mirror the shadow price of foreign exchange, as shown in Figure 5.

Figure 4 Inflation rate and official exchange rate

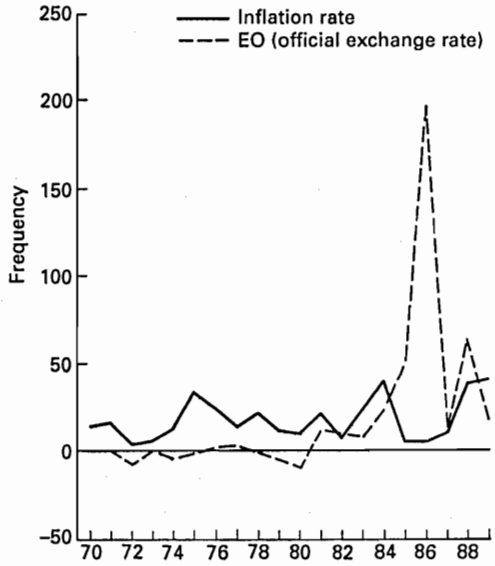
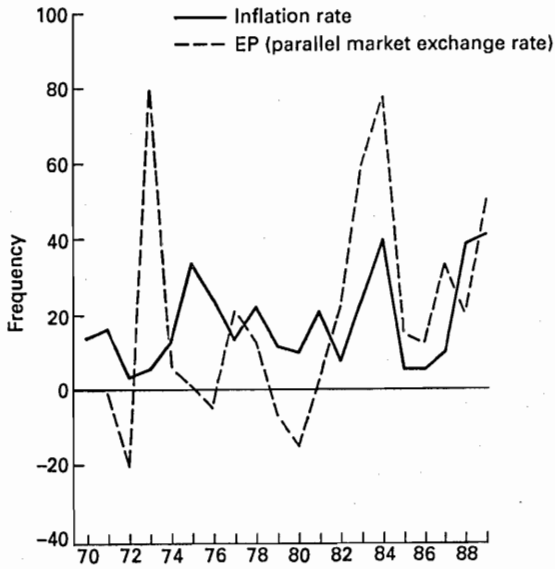


Figure 5 Inflation rate and parallel market exchange rate



The appreciation of the official exchange rate artificially cheapened competitive imports in relation to locally produced goods and services. With the massive import of consumer goods, raw materials and spare parts, the issue of imported inflation is easily appreciated when it is realised that in 1974–80 the mean yearly growth of the import price index registered 10.7% and inflation stood at 18.2%.

This was basically the situation between 1970 and 1980. From 1981, the structural weaknesses of the oil-propelled economy were exposed with the collapse of crude oil prices in the world market. It is almost incredible that the price per barrel of Nigerian crude oil, marginally above US$41 in January 1981, declined steeply to less than US$9 by August 1986. This had a direct impact on government revenue, as federally collected revenue declined from N15.2 billion in 1980 to N10.5 billion in 1983. The unchecked expansion of public expenditure under the civilian administration, which could not be serviced adequately by the shrinking revenue, generated a persistent budget deficit in the period. Not surprisingly, between 1981 and 1984, the cumulative budget deficit of the Federal Government was approximately N15.4 billion. Yet, the relationship between budget deficit and inflation (see Figure 1) in the reference period is practically non-existent. Perhaps this is due to the monetization of the deficits that exerted upward pressure on the general price level.

A striking revelation in the first half of the 1980s was the increase in domestic credit, with a sizeable proportion of this attributable to net claims on the government[6]. From N15.7 billion in 1981, the total domestic credit to the economy leapt to more than N30.0 billion in 1984. Correspondingly, net credit to the government accelerated from N6.3 to N17.8 billion. Although the annual growth of M1 was generally low in the first half of the 1980s relative to any period in the 1970s, the inflation rate climbed phenomenally from 21% in 1981 to almost 40% in 1984, although there was a big dip in 1982. Figure 2 shows that inflation in the early 1980s may not have been explained by monetary factors alone. Rather, structural factors could have accounted for inflationary trends during this period.

It will be recalled that there were supply shortages, particularly in 1984, due to import restrictions to correct the chronic balance of payment difficulties. Indeed, Figure 3 demonstrates that real GDP registered negative growth rates in 1981 and 1983–84, and the negative rates correspond to high rates of price inflation. The depreciation of the official exchange rate could have exerted some pressure on prices, as shown in Figure 4. But the picture that emerges in Figure 5 demonstrates a strong positive correspondence between inflation and the parallel market exchange rate relative to the official exchange rate identified in Figure 4.

The persistence of both internal and external disequilibria led to the implementation of the SAP in July 1986. The adoption of a realistic exchange rate via the SFEM, begun in late September 1986, is central to this. Available statistics reveal that the naira has depreciated steeply against the US dollar since then. On average, the naira, which before 1985 traded for almost N1.00:$1.00, stood at approximately N3.32:$1.00, a change of over 130%. The yearly percentage change of the official exchange rate has been very high indeed. Simultaneously, the rate of inflation accelerated from 5.4% in 1986 to about 41% by 1989. Figure 4 shows that there is some correspondence in the direction of movements between inflation and the nominal official exchange rate since 1987. Overall, the parallel market rate appears to correlate with inflation more than the official rate.

Demand management aspects of SAP emphasize reduced public expenditures and, therefore, a fall in budget deficit. Although, budget deficit/GDP ratio peaked at 11.9% in 1986, it declined remarkably to 5.5% in 1987 and rose through 8.5% in 1988 to 9.0% in 1989. However, the magnitude of the fiscal deficit increased from almost N5.9 billion to N15.3 billion between 1987 and 1989. This was partly financed from bank credit, with the rapid growth of money supply as the inevitable concomitant. In general, for this period, Figures 1 and 2 demonstrate a strong association between budget deficit/GDP ratio, money supply, and inflation.

In summary, two tentative conclusions emerge from trend analysis. First, the Nigerian inflation since 1970 can be explained by a combination of monetary and structural factors. This seems to confirm earlier empirical studies of inflation in Nigeria (see Section III). Second, exchange rate movement engenders price inflation. The parallel market exchange rate appears more significant than the official exchange rate in this respect. This suggests that prices may have adjusted to the shadow price of the exchange rate[7], (an empirical verification of this for Ghana can be found in Chhibber and Shafik (1990a)). Evidence from graphical representation suggests that the devaluation of exchange rates tends to slow the rate at which the parallel market exchange rate depreciates.

III Review of related studies

There is a vast body of empirical literature on inflation and this is usually dichotomized into two parts: the structuralist and monetarist perspectives[8]. Our brief review here is not bifurcated into the structuralist-monetarist controversy. We begin with studies on inflation in Nigeria.

In 1974, a national conference on inflation in Nigeria was organised by the Nigerian Institute of Social and Economic Research (NISER), Ibadan. Several aspects were addressed, but the papers prepared for Section Two of the conference focused on the proximate causes of inflation[9]. In general, the findings of some of the key articles reveal that neither monetary nor structural factors alone explain the Nigerian inflation. Striking evidence from this conference was that a combination of both factors precipitate the inflationary process.

Prior to the NISER conference on inflation, few studies had addressed the issue of inflation. The work of Oyejide (1972) is particularly appealing, as he takes the impact of deficit financing in the course of inflation as the focal point of his empirical enquiry. Having established the theoretical link between domestic money supply and inflation from the Fisherine equation, Oyejide determined statistically the impact of alternative definitions of deficit financing on inflation. Evidence from this research demonstrates that there is a direct correspondence, though not on a one-to-one basis, between the general price level and measures of deficit financing over the 14 years from 1957–70[10]. One point of importance from this is that less emphasis on deficit financing may limit the growth of price inflation in Nigeria.

The results of Ajayi and Awosika (1980) can be juxtaposed against this. An important conclusion from various econometric models employed by these authors indicates that inflation in Nigeria is determined largely by developments in the external sector, but complemented by internal influences. Specifically, their findings demonstrate that the openness of the economy is highly correlated with inflation. For Pinto (1987), the monetization of the foreign exchange earnings from crude oil export, that vastly expanded the growth of M1, constituted the single most important factor to explain movements in the general price levels in the 1970s to the early 1980s.

Elsewhere, the causes of inflation have been the preoccupation of several studies, particularly in recent years. It is important to document the findings of those related to the present study. In this respect, the work of Aghevli and Khan (1978) is illuminating. These authors developed structural equations to demonstrate the two-way causation between budget deficit and inflation in developing countries[11]. Empirical estimates from their study indicate that government expenditures respond faster to inflation than revenue, thereby generating an enlarged budget deficit which further engenders inflation.

Chhibber *et al.* (1989) developed a detailed econometric model which takes into account both monetary and structural factors in the course of inflation in Zimbabwe. Their investigation shows that monetary growth, foreign prices, exchange and interest rates, unit labour cost and real income are the determinants of inflation in this country. A similar macro-economic model of inflation was employed for Ghana by Chhibber and Shafik (1990a). This study, which covers 1965–88, suggests that the growth of money supply is one key variable explaining the Ghanaian inflationary process. Such variables as official exchange rates and real wages could not exert any significant influence on inflation. However, a significant positive relationship was found between the parallel exchange rate and the general price level. Perhaps one policy implication arising from this is that recent price movements in Ghana have little relationship with the recent exchange rate policy implemented by the government.

Still on the issue of inflation, Chhibber (1991) posits that there is no one-and-only-one relationship between exchange rate and price inflation. Basing his argument on empirical studies of some African countries, one of his main conclusions is that devaluation could exert upward pressure on the general price level through its increased cost of production in the short-run. For Chhibber, the extent to which devaluation of a local currency engenders inflation is largely a function of the impact of such policy measures on the revenues and expenditures (budget) of government, together with the monetary policy that is simultaneously pursued.

Probably motivated by the findings of Chhibber and Shafik (1990a), Sowa and Kwakye (1991) also undertook a study of inflationary trends and control in Ghana. A highly simplified econometric model was employed to determine the relative effects of monetary and structural factors on the general price level. Their results show that monetary expansion exerted some influence on inflation. On the impact of the exchange rate, this variable could not have a significant direct relationship with price movement, a confirmation of one of the findings of Chhibber and Shafik. From their findings, the conclusion of Sowa and Kwakye is that the Ghanaian inflation is structural in character.

Focusing on Uganda, Elbadawi's (1990) research revealed that rapid monetary expansion and the precipitous depreciation of the parallel exchange rate were the principal determinants of inflation during 1988–89. He concluded from the comprehensive review of exchange rate and price movements that devaluation of the official exchange rate is not inflationary. Obviously, this conclusion is consistent with the findings of Chhibber and Shafik (1990a) and Sowa and Kwakye (1991) with respect to Ghana.

The work of Tegene (1989) cannot be ignored. His method of analysis departs from others, as he does not utilize econometric techniques to investigate the role of domestic money supply in the course of inflation in six African countries. Rather, he employs the Granger and Piece causality tests[12]. Evidence from this study demonstrates a unidirectional causality, from monetary growth to inflation, in the sample countries. A similar analytical methodology was employed by Canetti and Greene (1991) to evaluate the relative contributions of exchange rate movements and monetary expansion to price inflation in ten African countries during 1978-89[13]. The broad conclusion that emerged from this comprehensive investigation is that exchange rate movement and monetary growth explain the inflationary trend in the study countries. In countries such as Sierra Leone, Tanzania and Zaire, the bivariate and trivariate Granger tests point out that the exchange rate has significant causal influence on inflation. With respect to the role of money supply, the statistical test identified causation from money to prices in Gambia, Sierra Leone and Uganda. As for Nigeria and Zambia, the various tests performed could not identify any significant causal relationship between money supply, exchange rate and inflation.

Earlier, London (1989) had examined the role of money supply and exchange rate in the inflationary process in 23 African countries[14]. The pure monetarist model of the Harberger type was employed and the results revealed that in the period between 1974 and 1985 the growth of money supply, expected inflation and real income were significant determinants of inflation in the sample countries. London, however, argued that because the results obtained give account only of the period averages of the countries studies, they should be seen as suggestive rather than definitive. In a related sense, the coefficients of the regressors may not adequately reflect the developments in a particular country; hence, the results should be interpreted with respect to a 'typical country on average over the period' (London, 1989, p. 95). The exchange rate was later introduced as one of the explanatory variables in the pure monetarist model. The results of this indicate that exchange rate movements had a significant impact on the inflationary process in the 1980s. Conversely, the growth of the money supply played a decreasing role in the

course of inflation on the continent. This possibly suggests that structural elements have been the proximate cause of inflation in recent years.

IV Conceptual links and the model

Analytical underpinning

The conceptualization of the linkages between exchange rate and budget deficit, on the one hand, and between each of these variables and inflation, on the other, is relatively straight-forward. This section sketches only the principal channels, beginning with the channels of transmission between exchange rate and inflation.

The 'pass through' argument is usually the basis on which the inflationary tendencies of exchange rate devaluation are premised. This is predicated on the assumption that the induced increases in the prices of imported inputs and final goods, following a devaluation of the local currency, will be passed on to domestic prices. From this it is obvious that this proposition has its roots in the cost-push theory of inflation. This is not to deny that theoretical and empirical strand of the literature which is predicated on the purchasing power parity (PPP) doctrine which is discussed in several papers (e.g. Leith, 1991; Balassa, 1964; Dornbush, 1987; and Edwards, 1989).

In general, there is high dependence on imported inputs for production by most developing countries. When there is devaluation, the domestic prices of imported inputs are raised and production costs are accordingly affected. Profits plus indirect taxes are usually mark-ups on producer prices to obtain ex-factory prices (and ex-factory prices plus distributor's margins equals market prices). In this sense, prices are formed on the basis of mark-up over cost of production. A highly simplified model of this is often represented as[15]:

$$P = M(W + eP^*)$$

where P represents the output price, M stands for 1 plus the fixed mark-up rate, W is the wage rate, e denotes exchange rate and P^* is the foreign price of imported inputs.

The above equation assumes a constant mark-up. But the argument has been advanced that the size of the mark-up is largely a function of excess demand in the economy. (Chhibber *et al.*, 1989, p. 7).

The rise in the general price level engendered by devaluation usually triggers a series of developments that often fuel the inflationary process. Even the rise in domestic prices without a corresponding increase in nominal wage rate reduces the real wage and a household has to spend more in order to maintain the same living standard. There is the tendency for labour to agitate for increases in wages and benefits. When such demands are granted, production costs and, therefore, market prices are affected accordingly. Of course, this is not inevitable if labour productivity increases correspondingly. For most developing countries, the government is the major employer of labour and as such, increases in wages have a tendency to raise public outlays: the rise in government expenditure generates budget deficit when the revenue collected is inadequate to meet the expansion in expenditures. This leads us to budget deficit-inflation links.

The channels of transmission between budget deficit and inflation are easily appreciated when the deficit is financed, in part, from increased Central Bank credit to the government. Two immediate direct effects of this can be identified. The increase in bank credit to the public sector expands aggregate demand and enhanced public expenditure has a tendency to raise private sector income and, therefore, demand for goods and services via the multiplier process. For a developing country that has a domestic limited supply of goods and services, the expansion in aggregate demand tends to exceed supply and a sustained rise in the general price level inevitably results.

The second effect is easily understood and domestic money supply is central to this. The growth of bank credit directly influences the growth of the money base (i.e., high-powered money) which, in turn, expands the growth of the money supply. The direct correspondence between money and price inflation is well known. Even within this monetary framework, it has been argued that the existence of an excess supply of real money balances directly stimulates real private expenditure.

We now explore the relationship between the exchange rate and budget deficits. This task has been simplified by the work of Chhibber *et al.* (1989). Exchange rate movements simultaneously affect both the revenue and expenditure sides of the budget. When there is devaluation, for instance, external debt and debt service payments in domestic currency rise. Thus, a component of the overall public expenditure is increased.

Theoretically, because devaluation stimulates the production of exports, it raises the income of exporters and subsequently increases revenue generated from taxes (Corden, 1989). Revenues from export duties rise with increased

export production consequent upon devaluation of the exchange rate. The extent to which the volume of import decreases is a function of the price elasticity of demand. But Corden (1989) argued that a devaluation of the exchange rate raises the domestic currency value of government imports. Changes in the level of imports affect revenue realised from customs duties.

It follows from this that the net effect of exchange rate movements on the budget is largely a function of tax structures and expenditures. Should the net effect be fiscal deficit that is monetized, inflation results. Both government expenditure and revenue adjust to inflation disproportionately and an enlarged budget deficit is generated if expenditure responds faster than revenue. Perhaps this discussion presents the two-way causality between inflation and budget deficit, as they feed on each other through what is referred to in the literature as the Keynes-Olivera-Tanzi effect (Tanzi, 1977)[16].

Model description

The macroeconomic model developed here takes account of the principal linkages and reflects some of the indications from preliminary observations presented earlier. It follows that the central issue of determining the quantitative impact of exchange rate adjustments on budget deficit and the price level is considered. Specifically, the macro model consists of a number of equations explaining price behaviour, domestic money supply and government budgetary developments. These are discussed in turn.

Price equation

The price equation considers the monetarist variables in addition to the exchange rate. Thus, price is functionally related to money supply, real output, expected rate of inflation and exchange rate, so that:

(1) $$\ln P_t = a_0 + a_1 \ln M_t + a_2 \ln YR_t\, a_3\, pe_t + a_4\, e_t;$$

$$a_1 > 0; \qquad a_2 < 0; \qquad a_3 > 0; \qquad a_4 > 0$$

where P stands for inflation, *M* represents money supply (broadly defined), *YR* is real output proxied by real *GDP*, and *pe* and *e* are expected rate of inflation and change in exchange rate, respectively[17].

It is hoped that the results of this equation will help to determine the relative contributions of monetary factors and exchange rate to inflationary developments in Nigeria.

Revenue equations

For simplicity, total government revenue is broken down into three components: petroleum revenue (also called oil revenue, (PR)), revenue from import duties (MR) and other government revenues (OR). That is:

(2) $$GR_t = PR_t + MR_t + OR_t$$

Revenue from import duties is directly related to import level which, in turn, is influenced by exchange rate. This function which is expressed in log-linear terms is as follows:

(3) $$\ln MR_t = B_0 + b_1 \quad \ln (MT.e)_t$$

where MT stands for the value of imports in foreign currency (expressed in US dollars).

Next are other government revenues. These are determined by nominal income *(Y)* and other government revenues lagged one year, so that:

(4) $$\ln OR_t = c_1 + c_1 \quad \ln Y_t + c_2 \quad \ln OR_{t-1}$$

$$c_1 > 0; \qquad c_2 > 0.$$

Exchange rate movements affect the value of a country's exports and, therefore, revenue generated from export duties. But an export revenue equation could not be specified along with the revenue from import taxes — as customs duties — simply because revenue from the former source paled into insignificance from the mid–1970s. Moreover, from the 1987 fiscal year, the Federal Government had eliminated export taxes as part of the open-handed policies to boost non-oil exports. For these reasons, income from export duties is considered under other government revenues.

Oil revenue is exogenously determined. This is because crude oil exports and the price are determined by the Organisation of Petroleum Exporting Countries (OPEC). However, it is recognised that with the devaluation of the

naira, revenue from crude oil export in local currency has increased considerably; and, by definition:

$$PR_t = (PRF.e)_t \tag{5}$$

where PRF is the revenue from crude oil exports in US dollars.

Expenditure equations

Total government expenditure is divided into two for convenience. These are interest charges on external debt plus capital repayment (DS) and other government expenditures (GO).

$$GE_t = DS_t + GO_t \tag{6}$$

Interest charges on external debt and capital repayment depend on the magnitude of the debt in local currency (and its local equivalent depends on the prevailing exchange rate) and foreign interest rate. Thus, the estimated equation is specified as:

$$\ln DS_t = d_0 + d_1 \ \ln (FD.e)_t + d_2\, rf \tag{7}$$

where FD is the magnitude of foreign debt in US dollars and rf represents foreign interest on the debt.

Other government expenditures in real terms are explained by real income and the magnitude of real government revenue. The lag value of other government expenditures is included in this specification (as an adjustment lag) which tests the responsiveness of government expenditures to inflation. Thus, the estimated equation is as follows:

$$\ln (GOR)_t = e_0 + e_1 \ \ln YR_t + e_2 \ \ln (GRR)_t + e_3 \ \ln (GOR)_{t-1} \tag{8}$$

The justification for the inclusion of government revenue in Equation (8) is easily appreciated. Since the oil boom of the early 1970s, government expenditure has been influenced largely by the earnings from crude oil. Indeed, the Keynesian public expenditure-led growth pursued vigorously in this decade (1973–83) was precipitated by the size of government revenue. Even since 1984, emphasis on reduced public spending through rationalization has been sharpened by reduced government revenue, brought about by the collapse of crude oil prices in the world market.

Budget deficit, domestic credit and money supply

It will be recalled from the introduction that government budget deficit and money supply are linked via the method of financing the deficit. Money supply is related to money base and is of the form:

(9) $$M_t = mMB_t$$

where m and *MB* stand for money multiplier and money base, respectively. The money base, on the other hand, is the sum total of budget deficit (BD), change in net foreign assets (NFA) and changes in other assets (OA) of the Central Bank.

(10) $$MB = BD_t + \Delta NFA + \Delta OA_t$$

It is assumed in this equation that government budget deficit is financed by borrowing from the Central Bank of Nigeria. Therefore, that proportion of the deficit which is financed by the Central Bank is represented by BD. Budget deficit is endogenised in the system and it is defined as the difference between government expenditure and revenue, so that:

(11) $$BD_t = GE_t - GR_t$$

A comment on the inherent logic of the model is imperative. Exchange rate movements affect the general price level and some components of revenue and expenditure. For instance, exchange rate depreciation, which raises the interest charges and capital repayment on external debt in local currency, will inevitably increase the overall government expenditure. Assuming the depreciation of the naira significantly engenders price inflation, this has implications for expenditure. Moreover, the net effect of exchange rate movements on the budget is a function of the structure of taxes and expenditure, and their corresponding response.

Assuming revenue lags behind expenditure, the overall effect is fiscal deficit and this constitutes an important component of the money base. The growth of the money base expands domestic money supply which, in turn, accelerates the inflationary process. Note, however, that the expansion in government revenue, enhanced by depreciation of the naira, will boost public expenditure, which can also exert upward pressure on the general price level through several other channels. A complete list of the model variables is provided in Appendix A.

Data sources

The model is estimated with the ordinary least squares (OLS) method, utilising annual data covering the period between 1973 and 1989. Relevant statistics are collected from various sources. The following variables — money supply, real GDP and its deflator, consumer price index, and official exchange rate — are obtained from the International Monetary Fund (IMF) *International Year Book 1991*. Government revenues and expenditures, imports and external debt and debt service payments are collected from the Central Bank of Nigeria's publications: 1. *Economic Review and Financial Review*, various issues; and 2. *Annual Report and Statement of Accounts*, various years. The parallel market exchange rate is obtained from *World Currency Year Book*.

V Model estimation and solution

This section focuses on the empirical estimates of the structural equations developed in the preceding sections and also contains the model solution.

Model estimation

In line with recent developments in time series modelling, unit root tests on the relevant economic variables in the model were performed to determine their time series characteristics. These tests are basically required to ascertain the number of times a variable has to be differenced to arrive at stationarity[18]. The syllogistic reasoning here is that there is the problem of 'spurious regression' when non-stationary series are estimated at their levels in a stochastic equation. It follows, therefore, that knowing the order of integration of macroeconomic variables helps in a model specification. Following the general classification, economic variables that are stationary are called I(0) series and those that have to be differenced once to obtain stationarity are called I(1) series. These are also called random walk. There are those that have to be differenced more than once to achieve stationarity, however.

Fairly sophisticated methods are available to evaluate the time series characteristics of macro variables. Some of the currently employed methods are the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF), and Sargan-Bhargava Durbin-Waston (SBDW) tests[19]. The DF test is a test against the null hypothesis that there is a unit root of I(1) of the series and the test utilises the equation of the form:

$$\Delta X_t = aX_{t-1} + \sum_{i=1}^{n} bi\ \Delta X_{t-1} + W_t$$

The test employs the t-statistic on the coefficient of the lagged independent variable. Thus, the null hypothesis is rejected if the t-value (which is expected to be negative) is significantly different from the critical value, say at the 5% level of significance, for a particular sample size. The ADF test is virtually the

same as the DF test, except the lag length has to be long in order to reflect the additional dynamics that could not be captured by the DF test and also possibly to ensure that the error term is white noise. Despite the usefulness of these tests, it is often suggested that they should not be considered as final in determining the time series characteristics of economic variables.

Beyond this, researchers also test whether there is a long-run relationship between a dependent variable and its regressor(s). Indeed, this is the pre-occupation of cointegration analysis with error correction model (ECM) that is gradually gaining popularity among economists and econometricians[20]. The processes for testing for the existence of cointegrating relationship are twofold, using the Engle-Granger procedure (see Engle and Granger, 1987). First, conduct unit root tests on the individual series and if the variables of interest are I(1), a static model is estimated for the cointegrating regression.

The second stage is to evaluate the order of integration on the residuals generated from the static model. The t-statistic of the coefficient of the regressor using the DF and ADF tests determines whether we should accept cointegration or not. When the absolute value of the t-statistic is greater than the critical values, then the existence of cointegration with respect to such macro variables cannot be rejected. What this suggests is that an error correction specification would provide a better fit than would be the case without it.

In appreciation of the above, both the DF and ADF tests were conducted on all the economic variables required in our structural equations. The results of these are in Appendix B. Evidently, we could not reject the null hypothesis that these variables are non-stationary — I(1). But, for such variables — external debt (ED) and debt service payment (DS) — are all I(2) series. These tests revealed that inflation is I(1) series. This implies that it has to be differenced once to obtain I(0). Thus, the second natural logarithmic difference of the consumer price index (CPI) represents this — rate of inflation.

In addition to this, the existence of cointegration between the regressands and relevant regressors were conducted for other equations. The results of the long-run solutions of the cointegrating relationships are shown in Table 2. A statement on each of these equations is useful here. The positive coefficient of money supply in Equation (a) is consistent with theoretical expectation and could be interpreted to mean the long-run relationship between price inflation and money supply. Evidently, in the long-run, revenue collected from taxes in real terms is a positive function of real imports, as indicated in Equation (b).

It is revealed in Equation (c) that the long-run relationship between other government revenue and income in real terms is positive. It should be noted that the theory of tax structure development argues that as economic development proceeds, more and more revenue tends to be internally generated

(Musgrave, 1969). Other government revenues here are mainly from internal sources (direct taxes mainly) and hence, the result of this static regression confirms the suggestion by economic theory. In regard to Equation (d), debt service payments are proportionally related to the magnitude of external debt in the long-run. The results of our behavioral equations, utilising the error correction term computed from these static regression models, are reported below (see Table 3).

Table 2 Long-run solution of the cointegrating relationship

(a)	$P_t = 0.6132\ M_t - 1.7623$
(b)	$MRR_t = 0.4384\ MTR_t + 6.0721$
(c)	$ORR_t = 0.6181\ YR_t - 3.7506$
(d)	$DS_t = 0.9883\ ED_t - 2.4104$

Note: Logarithmic specification was attempted in all the equations. The results of such statistics – R^2 and t-value – could not be reported, as they do not follow the expected distribution since the variables being modelled are non-stationary.

We can begin our interpretation with the results of inflation. Both the coefficients of growth in money supply and real output have their hypothesized signs and are statistically significant at the 5% level. Lagged rate of inflation used as a proxy for expected rate of inflation has a negative sign, a result inconsistent with theoretical expectation. Following this result, an alternative definition of expected rate of inflation, as in Olopoenia (1991), was employed (see footnote 17). Although the coefficient of this is positive, it is not statistically significant even at the 10% level. This is an indication, perhaps, that inflation expectation is not an important element in explaining the inflationary process during the period under study. The coefficient of lagged exchange rate (official) is highly significant, an indication that depreciation of the exchange rate exerts upward pressure on inflation — but it takes a minimum period of one year before this is reflected on price inflation.

Table 3 Estimate of behavioral equations[1]

1.	P_t	=	-0.0724 +	0.4370 M_t -	1.9400 Y_t +	0.1153 P_{t-1} +	0.2215 e_{t-1} -	0.1908ECM_{t-1}		
			(2.0824)	(2.7334)	(3.7361)	(0.6400)	(2.5329)	(2.3076)		
			R^2 = 0.7929	F(5,9) = 6.89 (0.0066)		DW = 2.12				
2.	MRR_t	=	-0.0790 +	0.6192 MTR_t -	0.3869 ECM_{t-1}					
			(1.3464)	(3.7448)	(2.1697)					
			R^2 = 0.6195	F(2,14) = 11.39(0.0012)		DW = 2.15				
3.	ORR_t	=	-0.0190 +	0.3869 Y_t +	0.4521 ORR_{t-1} -	1.1367ECM_{t-1}				
			(0.5240)	(1.9705)	(2.1003)	(4.9024)				
			R^2 = 0.6581	F(3,13) = 8.34(0.0024)		DW = 2.16				
4.	DS_t	=	-1.1073 +	0.6650 ED_t +	0.1764FR_t -	1.7132ECM_{t-1}				
			(1.2203)	(1.9202)	(1.5294)	(4.6404)				
			R^2 = 0.6249	F(3,12) = 7.22(0.0043)		DW = 1.98				
5.	GOR_t	=	-0.0525 +	0.3881 GRR_t +	3.7833 Y_t +	0.1358 GOR_{t-1}				
			(0.9042)	(1.0982)	(2.8752)	(0.8126)				
			R^2 = 0.6646	F(3,13) = 8.58(0.0021)	DW = 2.32					

Note: 1. Variables were estimated using natural logarithmic first difference, except ED and DS which were estimated using natural logarithmic second difference. Variables used in equations (2-3 and 5) are in real terms. All the equations were estimated using OLS and the econometric software employed is PC-GIVE (see Hendry, 1989).

Acceptance of this result implies acceptance of the fact that the country's price inflation is caused by both monetary and structural factors. It is pertinent to note that the long-run relationship between inflation and money supply is reflected in the coefficient of the ECM variable. The coefficient of the ECM indicates the speed of adjustment of inflation to money supply in the long-run. Thus, the feedback effect between inflation and money supply is 0.2.

The specification of revenue from imports as a function of the value of imports, and an error correction variable, yields a fairly good result. It is obvious that the volume of imports plays an important role in the determination of income generated from import duties (see Equation (2)). Also of interest is the elasticity of import taxes with respect to the volume of imports that is 0.62, a value less than unity. Clearly, it suggests that revenue from import duties responded slowly to imports during the estimation period. One presumed factor that accounted for this is the sharp decline in the country's imports in 1981–86, a development conditioned largely by inadequate foreign exchange earnings. Even the role of the import liberalization of 1974–77 cannot be ignored. However, the error correction coefficient in this equation indicates that the long run effect of imports on revenue through the feedback mechanism is relatively high, as it recorded a value of almost 0.39.

Other government revenues are explained in Equation (3). As indicated previously, the cointegrating statistics between this variable and real GDP could not reject the existence of cointegration; and hence, the need for an error correction specification, to capture the long-run dynamics between these series. Obviously, other government revenues are, to some extent, dependent on the growth of the economy.

Next is debt service payment. The performance of this equation is acceptable. Evidently, the rate of growth of external debt determines the growth in debt service payments. In turn, the expansion in the stock of external debt is directly related to the depreciation of the local currency. Although the coefficient of foreign interest rate on external debt has a positive sign, it is not statistically significant at the 5% level. It is pertinent to note that the coefficient of the ECM in this equation captures the short-run impact which is also tied to the long-run proportionality between external debt and debt service payment through the feedback mechanism. This is exceedingly low compared with what was recorded in each of the other equations.

The results of other government expenditures are contained in Equation (5). Evidence from this equation suggests that total government revenue is not an important determinant of other government expenditures. Instead, it responds significantly to the growth of the economy proxied by growth in real GDP. The value of the adjustment coefficient in this equation is almost 0.14 and it

is far from being statistically significant at the conventional level. In general, the descriptive statistics (R^2, F test and DW statistic) of this model are quite acceptable. It might be necessary to elaborate on the coefficient of income, however. This is because the elasticity of government expenditures with respect to income is greater than unity (the value is 3.78). It is possibly a reflection of Wagner's law of ever-increasing state activity which states that as the economy grows, government outlay tends to grow, at an even faster rate than GDP (Egwaikhide, 1984).

Overall, the model fits the data reasonably well. The results of all the equations confirm theoretical expectation, though, not all coefficients are statistically significant at the 5% level. Interestingly, however, the model is very dynamic through the use of lags, natural logarithmic difference and an error correction model. Moreover, the network of feedback mechanisms also makes the model more powerful than any of its behavioral equations. Yet, until the complete model is solved, its internal logic and consistency may not easily be appreciated.

Model solution

The system of equation was solved using Time Series Processor (TSP) econometric software (version 4.0) developed by Hall (1983). This software has two methods for solving a macroeconometric model of this nature. These are the Gauss-Seidel (see Ortega and Rheinboldt, 1970) and Fletcher-Powell (Fletcher and Powell, 1963) algorithms. The Gauss-Seidel iterative technique is employed here and it is quite simple, as it solves the equations sequentially, with each endogenous variable evaluated in turn.

A dynamic simulation of the model was conducted over the period 1975 to 1989. The idea is to assess the extent to which the model can be relied upon for short-run policy forecasting. The argument has been posited in econometric literature that even when all the individual equations of a large macro model fit the data reasonably well, using various statistical tests (e.g. DW-statistic, t-statistic, standard error of the regression, F test, R^2, etc), there is no guarantee that the model, when simulated, will be able to track the historical data very closely. Thus, this exercise is important as it allows us to gauge the internal consistency of the macro model developed.

We only present one important criterion for macroeconometric model evaluation often discussed in the literature (see, for example, Pindyck and Rubinfeld, 1981). This is the Theil's inequality and its decomposition[21] and the results are contained in Table 4.

Table 4 Theil's inequality coefficients and their decomposition for some key variables

Variable	Theil's inequality	Bias proportion	Variance proportion	Co-variance proportion
P	0.03914	0.02660	0.2459	0.72481
GOR	0.06458	0.03357	0.02999	0.93644
^{2}DS	0.30282	0.14990	0.24855	0.60155
ORR	0.06161	0.00519	0.14433	0.85047
MRR	0.07818	0.01014	0.09282	0.89597
M	0.11252	0.02360	0.08311	0.89329
GE	0.10306	0.04162	0.12702	0.83136
GR	0.09207	0.06480	0.05347	0.88173

In general, the values of the coefficients of the computed endogenous variables are small with the largest being 0.30 (registered by debt service payments). One plausible interpretation derivable from the smallness of the Theil's inequality coefficients is that there is an absence of any systematic bias and, consequently, the model may not need any major revision for the current purpose of it development.

Overall, it is evident that at least 88% of the variations in the variables presented in Table 4 were predicted by the model, except debt service payments. The inability to explain more than 70% of the variations in this variable may be due to its volatility, particularly in recent years.

It may be necessary to comment on the decomposition of the Theil's inequality coefficient. This decomposition, as demonstrated in Table 4, is nearly optimal, with a large part of the errors skewed in favour of the co-variance proportion for the variables, a result consistent with the requirements of a 'good' model.

VI Policy simulation results

Counterfactual simulation analysis addresses a number of questions of the 'what if' variety. Such questions are usually answered under two approaches: ex-post and ex-ante impact simulations (see Challen and Hagger, 1983). Our preoccupation here, however, is on ex-post simulation of the effects of exchange rate depreciation on specific economic variables of interest. To conduct this, we have to assume a particular percentage level of exchange rate depreciation. This task has been simplified by the exchange rate policy adopted on 5 March 1992, by the Central Bank of Nigeria (CBN). It is important to note that this policy attempts to close the gap between the official exchange rate and the parallel market rate, by devaluing the former. Thus, the assumption is made: supposing the Central Bank had allowed the exchange rate to float from early 1984, soon after the overthrow of the civilian government in December 1983, and in the process the naira depreciated, what would have happened to the relevant variables?

Available statistics indicate that Nigeria's official exchange rate in 1984 was N0.7642:US$1.0 and the parallel market rate recorded about N3.226:US$1.0. It follows, therefore, that the Central Bank needed to devalue the official exchange rate by about 76% (then) to bridge the gap between these rates; and so we adopt this percentage depreciation of the local currency in the simulation experiment during the six-year period 1984–89. A simple method is employed to present the results. First, the mean annual growth rates of the variables generated by the model solution are computed — this is called base line (control run) solution. Second, the official exchange rate was assumed to depreciate by 76% from 1984 (a once-and-for-all exercise) and the result of this is labelled as disturbed (shocked) solution[22]

The results of this experiment are shown in Table 5. It is obvious that this hypothetical situation will raise average annual growth rates of the key variables in the model, except real growth of other revenues which declined in the reference period. Specifically, price inflation would increase by an annual average of about 6% over the control solution and domestic money supply by almost 2.0%. The results of the model also specify that the average revenue (GRR) in the base line solution were 17.90 and 13.07%, respectively.

The difference between these figures was 4.83%. By the assumed percentage depreciation of the naira, real government expenditure seemed to have grown faster than state revenues, as the difference between these variables in the simulation experiment recorded 8.11% (8.11 > 4.83).

Table 5 Effects of exchange rate depreciation on budget and inflation: a simulation experiment (mean annual growth rate, 1984-89)

Variable	Base line solution	Disturbed solution
P	23.06	29.13
M	13.70	15.62
GOR	12.35	14.25
DS	56.14	65.28
MRR	11.78	13.40
ORR	2.58	1.13
GER	17.90	24.03
GRR	13.07	15.92

Note: Natural logarithmic first difference (multiplied by 100%) was employed to generate the growth rate.

This is possibly an indication of enlarged budget deficit (as it already exists) engendered by exchange rate reforms. On the basis of the model result, the increase in total government expenditure appears to have been fostered by the growth in debt service payment, with depreciation of the exchange rate raising the stock of external debt (a significant explanatory variable of debt service payments) in local currency enormously. Perhaps it is through the monetization of the increased revenues from the exchange rate liberalization that the expansion in money base became enhanced, with rapid growth in money supply and inflation as some of the derivatives. This is not surprising, as we found earlier from the results of the price equation that domestic money supply has both short- and long-run effects on inflation.

Following the depreciation of the naira, net foreign assets in local currency could expand. A direct result of this is increased money base and money supply which in turn feeds into price inflation. This could create budget deficit if expenditure responds to inflation faster than revenue. In this sense, the link between changes in net foreign assets and budget deficit is indirect[23].

The policy lesson for the above is easily discerned. It is clear from the simulation experiment that exchange rate depreciation affects both sides of the budget significantly, with total expenditure responding faster than total revenues. This development could generate budget deficit if not properly managed. This is particularly true when it is realised that exchange rate reform of this nature could be undertaken primarily to mobilise more revenues for government. If that is the case, the monetization of such earnings is likely to boost aggregate demand and possibly the money base and, consequently, fuel price inflation. We should also learn from the results that depreciation of the exchange rate has a tendency to expand debt service payments, since it raises the size of external debt remarkably. This is reflected significantly in government expenditure. Of course, this development can have adverse effects on investment which constitutes the motor of economic expansion — at least, in the short-run since increased debt service payments tends to crowd-out other expenditure categories, particularly capital outlay.

VII Conclusion

This study examined the quantitative effects of exchange rate depreciation on inflation, government revenues and expenditures, and money supply in Nigeria. Our objective was achieved through the use of a macroeconometric model that captures the key aspects of the linkages between the above variables. In the empirical estimates of the structural equations, we drew on recent developments on cointegration and error correction model which are rapidly gaining popularity among economist and econometricians. In addition to this, we relied on the use of trends in the relationship between inflation and other economic variables.

So far, our findings highlight several points of importance. Evidence from trend analysis suggests that domestic money supply, real output, the shadow price of exchange rate — the parallel market exchange rate — and, more recently, official exchange rate, cannot be ignored in evaluating the proximate causes of inflation in Nigeria. With particular reference to exchange rate, graphical representation reveals that the parallel market exchange rate appears to correlate with inflation more when compared with the official rate.

Statistical estimates of the structural equations are also quite revealing. The results of inflation equation demonstrate that official exchange rate is a significant determinant of price inflation, with a lag period of one year. Inadequate output and monetary expansion also featured prominently in this equation. But the coefficient of the expected rate of inflation, though positive, is not statistically significant even at the 10% level. Imports, influenced by exchange rate, significantly explain revenue from import taxes. The magnitude of external debt in local currency, which also depends on the exchange rate, has a tendency to increase debt service payments and, therefore, total expenditures, through a feedback mechanism using an error-correction term. All this has implications for budget deficit and growth in domestic money supply and thus inflation.

After testing for the internal consistency of the complete model, it was applied to evaluate the impact of exchange rate depreciation on such variables as money supply, revenues and expenditures, and inflation. Evidence from the model results, in which we assumed a floating exchange rate that eventually

lead to a depreciation of the naira, indicate that exchange rate depreciation can be inflationary. This works via its direct impact on inflation, and through budgetary and monetary effects. On average, the depreciation of the naira (by about 76%) seems to raise the growth of total expenditure more than total revenue.

This is an indication of an enlarged budget deficit (where budget deficit already exists, as in the case of Nigeria) or it can generate budget deficit over time. The monetization of the deficit expands the money base, resulting in inevitable growth in money supply.

This is contrary to the result obtained from trend analysis which indicates that inflation has already adjusted to the parallel market rate; and consequently devaluing the naira may not necessarily be inflationary. One important policy lesson is therefore obvious from the simulation experiment: namely that exchange rate depreciation significantly affects both the revenue and expenditure sides of the budget in Nigeria and it could enlarge the existing budget deficit if not properly managed. A restrictive monetary policy may be implemented to complement the exchange rate policy adopted.

Two important limitations of this research should be mentioned. First, is that the model employed is highly aggregative, particularly the revenue and expenditure components. In the disaggregated model, net foreign assets could be endogenized. Moreover, the effects of exchange rate reform on the productive base of the economy which, in turn, influences government revenue and inflation are not considered in the current research. To that extent, our findings, particularly from the model results, are more suggestive than definitive. A more detailed modelling of the interactions between exchange rate, budget, inflation and production is therefore required.

The second weakness has to do with the cointegration and error correction technique explored in the estimation of the structural equations. This methodology generally requires a large sample size to draw solid inferences for policy simulations. The sample size of the current estimate does not permit us to have great confidence in the results obtained.

Appendix A

Definition of the estimated model variables

Endogenous

BD	Budget deficit: defined as that part which is financed by the Central Bank of Nigeria.
DS	Debt service payments (annual).
GER	Total government revenue (real).
GOR	Other government revenue (real).
GRR	Total government revenue (real).
M_2	Money supply, broadly defined.
MB	Money base (BD + NFA + OA).
MRR	Revenue from import duties (real).
MTR	Merchandise imports (real).
ORR	Other government revenue (real).
P	Inflation.
PR	Revenue from crude oil in local currency (nominal).
YR	Real income.

Exogenous

e	Nominal exchange rate (official).
ED	External debt in local currency.
NFA	Net foreign assets.
OA	Other assets of the Central Bank.
PRF	Revenue from crude oil in US dollar (nominal)
rf	Foreign interest rate on external debt.

Appendix B

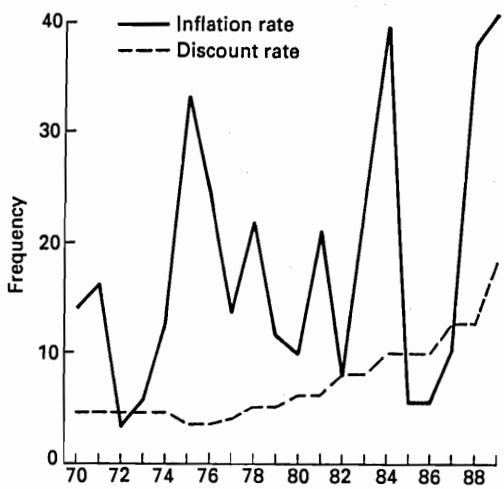
Unit root tests

Variable	Test[4]	a	SE[1]	t-value
Y	DF	-0.0039	0.0204	-0.1912
	ADF(3)	-0.0062	0.0232	-0.2672
YR	DF	-0.0690	0.0470	-1.4681
	ADF(3)	-0.0750	0.0572	-1.3112
M_2	DF	-0.0066	0.0185	-0.3568
	ADF(2)	-0.0080	0.0199	-0.4020
MTR	DF	-0.0128	0.0459	-0.2789
	ADF(3)	-0.0175	0.0529	-0.3308
ORR	DF	-0.0099	0.0296	-0.3345
	ADF(2)	-0.0010	0.0266	-0.0376
GOR	DF	-0.0239	0.0381	-0.6273
	ADF(2)	-0.0358	0.0404	-0.8738
GRR	DF	-0.0037	0.0350	-0.1057
	ADF(2)	-0.0153	0.0374	-0.3556
ED	DF	-0.0376	0.0477	-0.7883
	ADF(2)	-0.0228	0.0489	-0.4663
DS	DF	-0.0380	0.0793	-0.4792
	ADF(2)	-0.0245	0.0582	-0.4210
P	DF	-0.6743	0.2439	-2.7646[3]
	ADF(4)	-0.3891	0.3437	-1.1321
MRR	DF	-0.0048	0.0572	-0.0839
	ADF(2)	-0.0002	0.0035	-0.0031

Notes:
1. SE = Standard error
2. Critical values at 1 and 5% level of significance are -1.95 and -2.66 for sample of 25, respectively.
3. The null hypothesis is rejected at the 5% level of significance, an indication that inflation is I(0). But the low power of the ADF test reveals that inflation is I(1). This is more reliable, as it is more powerful than the DF test.
4. DF = Dickey-Fuller test. ADF = Augmented Dickey-Fuller test (the number in parenthesis indicates the lag length).

Appendix C

Inflation rate and discount rate



Notes

1. For a detailed discussion of the objectives and policy instruments of SAP, see Federal Republic of Nigeria (1986).

2. The key petroleum tax reforms implemented by the Federal Government are contained in Iwayemi (1981).

3. On this, see Oyejide (1985a).

4. The article by Schatz (1984) presents an excellent discussion on Nigeria's inert economy without oil.

5. A historical sketch of Nigeria's exchange rate policy are in Oyejide (1985b), Ogun (1990), and Ajayi (1988).

6. An excellent discussion of this development is presented by Pinto (1987). The theoretical underpinnings of his submission are in Morgan (1979) and Olopoenia (1986), among others.

7. Pinto (1989: 333) noted earlier that inflation reflects movements in Nigeria's parallel market exchange rate, on the basis of some calculations.

8. Fitzpatrick and Nixson (1976) present a detailed review of the monetarist-structuralist debate on inflation. A widely-cited empirical study of structural causes of inflation is that of Argy (1970). On the origin of structuralism, see Arndt (1985).

9. On some of the papers, see Adejugbe (1974), Adeyokunu and Ladipo (1974), Ajayi and Teriba (1974), Ojo (1974), Owosekun and Odama (1974).

10. Four alternative measures of deficits were employed. These are: 1. change in the narrow definition of money (M1); 2. domestic credit creation; 3. internal credit monetisation defined as increase in money supply plus the reduction in net gold and foreign reserves; and 4. draw-down of foreign reserves. For elaboration, see Oyejide (1972). A recent study by Ariyo and Raheem (1990) utilizes a broad definition of deficit financing and economic development in the country. On the sources of financing budget deficit in Nigeria, see Mbanefoh (1982).

11. See Aghevli and Khan (1978) for the internal logic of the structural equations developed.

12. On this, see Granger (1969).

13. Only Granger causality tests were, however, performed. Perhaps, it is important to emphasize that the techniques of Vector Autoregressive (VAR) analysis of bivariate and trivariate tests were employed in this research.

14. An interesting study on the link between exchange rate and the general price level in Botswana has been conducted by Leith (1991).

15. Sophisticated mark-up models demonstrating the impact of exchange rate on prices are available. For example, see Ajakaiye (1990).

16. Empirical testing of this was attempted by Aghevli and Khan (1978). The works by Chhibber *et al.* (1989), and Chhibber and Shafik (1990a) also provide some useful estimates with respect to Zimbabwe and Ghana, respectively.

17. The expected rate of inflation is along the line employed in a recent study by Olopoenia (1991). In this formulation, the expected rate of inflation is related to its past values, so that:

$$pe_t = a_0 + \sum_{i=1}^{n} bi \ln P_{t-1}$$

where pe is the expected rate of inflation and p is actual inflation.

18. A simplified presentation of stationary and non-stationary processes of time series variables and their relevance in econometric modelling can be found in Yoshida (1990, pp. 20-24).

19. On the first two tests, see Yoshida (1990, pp. 24-26). For the Sargan-Bhargava Durbin-Waston test (SBDW), see Sargan and Bhargava (1983), and Engle and Granger (1987).

20. Recent studies on the use of cointegration and an error correction model are available. Among them are Hendry (1986), Domowitz and Elbadawi (1987), Yoshida (1990), Chhibber and Shafik (1990b), Hendry and Ericsson (1991), and Adam (1991).

21. The inequality was introduced by Theil (1961, pp. 30-37) and is of the form:

$$T = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{N}(P_i - A_1)^2}}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(p_i)^2} + \sqrt{\frac{1}{n}\sum_{i=1}^{n}(A_i)^2}}$$

where P = predicted value
A = actual value;
n = sample size.

The numerator is the root-mean square error (RMSE) and the denominator represents weights which constrained the value of T to $0 \leq T \leq 1$. The closer the value of T to zero, the better are the results of the dynamic historical simulation. On the derivation of the decomposition, see Theil (1961; 1966).

22. Several variants of this approach have been used by various authors. For example, see Salvatore (1983), and Nziramasanga and Obidegwu (1981).

23. In the simulation experiment, we assume neutrality of other government policies. For this reason, we did not critically assess the impact of net

foreign assets on budget deficit. Even in the development of the model, the role played by net foreign assets was not central.

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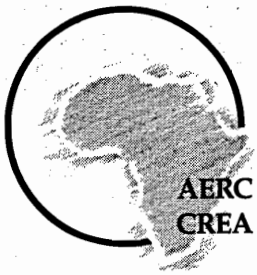

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ISBN 9966-900-13-6