EXCHANGE RATE MOVEMENTS, PRICES AND INFLATION IN THE NIGERIAN ECONOMY: A MACROECONOMETRIC ANALYSIS

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Division Working Paper No. 1987-3
February 1987

Country Analysis and Projections Division
Economic Analysis and Projections Department
The World Bank

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I would like to thank Borje Tallroth and the participants in an EPDCO seminar for comments on earlier work on the macromodel which has been used in this paper. Valuable research assistance was provided at various stages by Vargha Azad, Nick Nteireho and Barbara Ossowicka.
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EXCHANGE RATE MOVEMENTS, PRICES AND INFLATION

IN THE NIGERIAN ECONOMY: A MACROECONOMIC ANALYSIS

The Nigerian economy has been in a deep recession since 1981, the end of the oil boom. Export receipts have fallen substantially and imports have had to be drastically cut. A maxi devaluation of the naira was proposed in 1982 but it met with strong opposition from the public and many in government. This opposition was engendered by strong nationalistic sentiments, fears of runaway inflation and economic stagnation. Echoing the structuralist critique, some argued, that devaluation would not be effective in promoting exports or reducing import intensity but would only add to inflationary pressures. In 1986, after four years of economic stagnation and debate on foreign exchange policy, the government instituted an auction system for the determination of the exchange rate and foreign exchange allocation. This has led to the defacto devaluation of the Naira. Despite this, the issue of the relationship between devaluation, inflation and economic performance in the Nigerian economy is far from settled.

This study uses a macromodel of the Nigerian economy to investigate the impact of devaluation on the price level, inflation and relative price movements. It goes on further to look at the impact of those relative price changes on production and the balance of payments as well as domestic policy options for reducing any inflationary tendencies of devaluation and strengthening productive effects. The study finds that devaluation raises the price level but does not lead to runaway inflation, and that fiscal and trade policies can be effective
in reducing both the price level and inflation. Devaluation by itself tends to strengthen the current account balance by increasing exports and reducing imports. In the medium term, devaluation raises output in agriculture and manufacturing and overall gross domestic product. These production increases are further strengthened by policies of cuts in government expenditures and/or tariff rates.

INTRODUCTION

The concern about the inflationary impact of devaluation is generally on two grounds, namely, (i) inflation is an inferior "good", (ii) as a part of a trade policy package, the objective of nominal devaluation is to achieve a depreciation of the real exchange rate through a nominal devaluation. This devaluation could generate a change in the price level that could result in no real depreciation of the exchange rate. Thus to achieve a target real devaluation of the exchange rate policy makers would need to know the magnitude of the impact of exchange rate changes on the domestic price level in order to fix the new nominal rate. Policy makers are usually constrained in their choice of a new level of the nominal rate by a politically acceptable inflation rate.

The impact of devaluation on absolute and relative prices and the inflationary process in a given economy will depend on the structural and policy characteristics of the economy. In the short term, the impact would largely depend on the proportion of traded goods in total expenditure, the elasticity of supply and demand for non-traded goods, the degree of competition in the goods and labor markets, the existence of slack in the economy, the effectiveness of any controls on
prices in the economy and the monetary, fiscal and trade policies of the government. In the long run, price adjustments delayed by policy distortions take place, and resources shift from non-traded goods to traded goods. The more there is this resource shift, the price of non-traded goods will tend to rise, thus raising the overall price level. No analytical model can capture the impact of these factors as well as their intertemporal dimensions. Thus analytical models normally focus on the more tractable factors and abstract from the rest.

Another important factor affecting price changes following a devaluation is expectations, which is difficult to measure and model. Typically a country needs to devalue because its inflation rate exceeds the weighted average of the inflation of its trading partners. Relatively speaking, that country has an inflation problem, and economic agents have built up arsenals of defensive mechanisms. The impact of devaluation on the price level may be different from what simple models predict because of dynamic expectations. A devaluation today, given today's expectations of inflation, may be taken as a signal for further devaluations. Such a signal would then be used to revise today's prices.

In summary, the impact of devaluation on the price level depends on the composition of expenditure (traded vs non-traded goods), the short and long-term price elasticities of demand and supply of traded and non-traded goods, the competitive structure of the economy, government, fiscal, monetary and trade policies, and the other factors that affect the expectations of economic agents.

The impact of devaluation on the price level can be studied by single equation models of the price formation in the economy [for
example, Bruno and Sussman (1979) and Corbo (1985)). These models usually have, as one of the explanatory variables, import prices and/or the exchange rate. While this is an inexpensive way of studying the impact of devaluation, it does not allow for the exploration of the impact of policy responses or for the determination of the macroeconomic effects of the devaluation and associated policy responses and choices. Policy choices and responses are clearly very important as shown by analytical models. Khan and Lizondo (1986) showed that the impact of devaluation on the domestic price level (and thus the real exchange rate) depends on the associated policy choices. Rodriguez (1978) using an analytical model also showed that under fixed exchange rate, the presence of a real government deficit financed through credit creation by the central bank generates an inflation-devaluation spiral.

A study of the impact of exchange rate adjustments on the domestic price movements must consider the structure of the economy as well as potential policy responses. These can be captured in a simultaneous equation macroeconomic model. This paper therefore explores the impact of exchange rate adjustments on the price level, inflation and other macroeconomic variables in the Nigerian economy using a macroeconomic model. This is done by model simulations using different time sequences of nominal exchange rates and measuring the incremental impact on the selected macroeconomic variables. Model simulations are also used to explore the efficacy of trade, fiscal and monetary policies in stemming the inflationary impact of the devaluations.

The rest of the paper is divided into four parts. Section I describes the historical evolution of the Nigerian economy, its exchange
rate and related policies as well as its trade performance. This sets the background for Section II, which describes the macromodel to be used for the study. Section III describes the results of various model simulations and Section IV provides concluding remarks.

I. THE NIGERIAN ECONOMY

The Nigerian economy has entered a fourth phase of its existence. In the first phase, which ended in 1973, Nigeria was a largely agricultural economy, exporting crude oil as well as substantial volumes of agricultural commodities, namely, cocoa, palm produce and groundnuts. For the last two products, Nigeria was in each case, the largest exporter in the world, and in the case of cocoa, the third largest exporter, behind Ghana and Brazil. The second phase is the oil price boom period, starting in 1973 when all prices rose sharply, and ending in 1981, when oil prices peaked before starting on a downward path. This oil boom changed the structure of the Nigerian economy with oil production becoming a substantial portion of GDP and crude oil providing a dominant share of exports.

The oil boom was followed by a third phase during which oil prices were declining, economic performance very sluggish, and more importantly, there was a national search and debate on the appropriate economic policy direction for the post oil-boom period. In 1986 a fourth phase emerged and with it indications of the policy direction that crystallized from the debates, reflections and disappointments of the third phase. It brought the prospect of sweeping economic reforms, with more liberal trade and domestic policies, market determined
exchange rates and a reduction in the role of the government in economic activity.

During the oil boom (1974-81), the economy changed substantially. Oil became dominant, manufacturing activity somewhat accelerated based on abundant and cheap imports of capital and raw materials, agriculture stagnated but construction, wholesale and retail trade and other non-traded sectors expanded rapidly. (See Table 1). Petroleum receipts increased government revenues and government spending rose as more resources became available. The boom strengthened the overall role of the government in the economy vis-a-vis the private sector.

The oil boom made the Nigerian economy highly dependent on petroleum as the principal source of export and government revenues. A combination of increased domestic absorption of traditional exportables, controls on exports and export prices, labor shortages in the agricultural sector, and the sustained real appreciation of the Naira (see Fig. 1) led to a steep decline in traditional agricultural exports. There was little incentive for manufacturing exports to develop as a result of seemingly insatiable domestic demand and appreciating real exchange rates. Thus by the end of the boom, Nigeria's dependence on petroleum exports was almost complete, with petroleum contributing close to 99 percent of merchandise exports in 1980 (see Table 2 for the structure of exports).

1/ Because of the manner in which the exchange rate is defined, a rise in the index implies real appreciation.
Table 1: GROWTH AND DISTRIBUTION OF DOMESTIC EXPENDITURES AT CONSTANT PRICES

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<td></td>
<td>3.4</td>
<td>3.9</td>
<td>12.0</td>
<td>3.3</td>
<td>-3.6</td>
<td>-8.9</td>
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<td><strong>Consumption Expenditures</strong></td>
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<td>2.1</td>
<td>4.7</td>
<td>13.3</td>
<td>16.7</td>
<td>5.4</td>
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<td>17.4</td>
<td>6.8</td>
<td>-11.0</td>
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<td></td>
<td>11.2</td>
<td>3.3</td>
<td>-17.7</td>
<td>13.0</td>
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<td>0.8</td>
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<td><strong>Gross Investment</strong></td>
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<td>9.2</td>
<td>15.1</td>
<td>14.0</td>
<td>-24.9</td>
<td>-20.3</td>
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<td>**Exports of GNFS (adj) b/</td>
<td></td>
<td>10.2</td>
<td>5.7</td>
<td>18.6</td>
<td>-13.4</td>
<td>-26.8</td>
<td>-17.0</td>
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<tr>
<td>Exports of GNFS</td>
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<td>-23.6</td>
<td>-4.6</td>
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<tr>
<td><strong>Imports of GNFS</strong></td>
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<td>13.8</td>
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<td>100.0</td>
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<td>87.8</td>
<td>76.5</td>
<td>69.0</td>
<td>71.2</td>
<td>85.0</td>
<td>84.7</td>
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<td>81.1</td>
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<td>63.6</td>
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<td>75.1</td>
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<tr>
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<td>5.1</td>
<td>6.7</td>
<td>9.5</td>
<td>7.4</td>
<td>7.6</td>
<td>8.6</td>
<td>9.6</td>
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<tr>
<td><strong>Gross Investment</strong></td>
<td></td>
<td>8.8</td>
<td>14.3</td>
<td>20.7</td>
<td>15.7</td>
<td>26.9</td>
<td>24.4</td>
<td>21.4</td>
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<tr>
<td>**Exports of GNFS (adj) b/</td>
<td></td>
<td>7.6</td>
<td>10.9</td>
<td>15.6</td>
<td>29.3</td>
<td>30.3</td>
<td>20.1</td>
<td>18.3</td>
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<tr>
<td>Exports of GNFS</td>
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<td>29.8</td>
<td>43.8</td>
<td>24.9</td>
<td>21.2</td>
<td>11.4</td>
<td>12.0</td>
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<tr>
<td><strong>Imports of GNFS</strong></td>
<td></td>
<td>-10.6</td>
<td>-13.0</td>
<td>-12.8</td>
<td>-13.5</td>
<td>-25.2</td>
<td>-29.6</td>
<td>-24.4</td>
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a/ Period growth rates calculated by least squares method.

b/ Exports of goods and non-factor services adjusted for terms of trade changes.

Sources: Federal Office of Statistics and World Bank.
Figure 1
NIGERIA
REAL EFFECTIVE EXCHANGE RATE & CPI

CPI(1980=100)  REER(1965=100)

Table 2: DISTRIBUTION OF EXPORTS OF MAJOR COMMODITIES (%)

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<tr>
<td>Crude Petroleum</td>
<td>16.2</td>
<td>41.0</td>
<td>88.9</td>
<td>96.0</td>
<td>99.0</td>
<td>97.5</td>
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<tr>
<td>Cocoa</td>
<td>25.7</td>
<td>30.3</td>
<td>7.6</td>
<td>3.6</td>
<td>0.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Palm Oil</td>
<td>7.4</td>
<td>0.7</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Palm Kernels</td>
<td>16.5</td>
<td>4.3</td>
<td>1.2</td>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>34.2</td>
<td>23.6</td>
<td>2.3</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Major Export Commodities</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Major Export Commodities as % of Exports of Goods</td>
<td>-</td>
<td>75.5</td>
<td>92.0</td>
<td>96.8</td>
<td>99.8</td>
<td>-</td>
</tr>
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The intensity and structure of imports changed radically with the oil boom. As shown in Table 1, imports expanded rapidly between 1974 and 1981, reaching about $24 billion in 1981. Imports of goods and non factor services as a proportion of gross domestic income (GDI), peaked at 30 percent in 1982 compared to 11 percent in 1960. If the 1974 structure is taken as an indication of pre-oil boom distribution, the shifts in structure of imports are significant. The proportion of foods and manufactures in the import basket rose while the proportion of fuels and intermediates declined. Overall there was a shift towards consumption goods away from capital goods and intermediates. The proportions of imported foods and manufactures in private consumption, imported capital goods in gross investment and intermediate goods in industrial production, shifted upwards during the oil boom. In sum,
Table 3: DISTRIBUTION OF MERCHANDISE IMPORTS IN CURRENT VALUES (%)

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<tr>
<td>As a Proportion of Total</td>
<td></td>
<td></td>
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<tr>
<td>Merchandise Imports</td>
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<tr>
<td>Foods</td>
<td>8.9</td>
<td>10.4</td>
<td>15.8</td>
<td>16.3</td>
<td>15.2</td>
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<tr>
<td>Fuels</td>
<td>3.2</td>
<td>1.8</td>
<td>1.7</td>
<td>1.4</td>
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<td>Capital Goods</td>
<td>37.2</td>
<td>48.1</td>
<td>33.5</td>
<td>32.8</td>
<td>32.5</td>
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<tr>
<td>Manufactured Consumption</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goods</td>
<td>17.7</td>
<td>16.6</td>
<td>22.2</td>
<td>24.3</td>
<td>25.3</td>
</tr>
<tr>
<td>Intermediates</td>
<td>32.9</td>
<td>23.1</td>
<td>26.8</td>
<td>25.2</td>
<td>25.5</td>
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<tr>
<td>Selected Import - Related</td>
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<td>Total Merchandise/GDP</td>
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<td>21.8</td>
<td>18.8</td>
<td>24.5</td>
<td>20.2</td>
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<tr>
<td>Foods/Value Added in</td>
<td>3.4</td>
<td>10.0</td>
<td>14.3</td>
<td>16.5</td>
<td>12.1</td>
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<td>Agriculture</td>
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<td>Foods/Private Consumption</td>
<td>1.4</td>
<td>4.0</td>
<td>4.9</td>
<td>5.3</td>
<td>4.1</td>
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<tr>
<td>Manufactured Consumption</td>
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<td>6.4</td>
<td>6.9</td>
<td>7.9</td>
<td>6.7</td>
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<tr>
<td>Goods/Private Consumption</td>
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<tr>
<td>Imports of Capital Goods/</td>
<td>20.4</td>
<td>34.4</td>
<td>26.3</td>
<td>36.4</td>
<td>33.9</td>
</tr>
<tr>
<td>Gross Investment</td>
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<tr>
<td>Imports of Raw Materials/</td>
<td>86.6</td>
<td>105.5</td>
<td>103.6</td>
<td>116.0</td>
<td>104.5</td>
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<tr>
<td>Value Added in Manufacturing</td>
<td></td>
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<tr>
<td>Imports of Intermediates/</td>
<td>25.1</td>
<td>29.9</td>
<td>34.1</td>
<td>42.1</td>
<td>36.3</td>
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<tr>
<td>Value Added in Industry b/</td>
<td></td>
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a/ All variables are in current values.

b/ Industry is composed of manufacturing, construction, utilities, non-oil mining and quarrying.

Source: Federal Office of Statistics, CBN.
there was a marked and widespread intensification of imports in all sectors and activities as a result of the oil boom.

In spite of the efforts of the government to keep down inflation through direct price controls, over-valued exchange rates and importation of consumer goods, inflation, as measured by the consumer price index, accelerated during the oil boom (see Fig. 1). The compound annual rate of inflation was 17 percent between 1973 and 1983 compared to 4.5 percent between 1960 and 1972. The high inflation of the oil boom period was the result of expansionary fiscal and monetary policies which were in place until 1983. Between 1973 and 1983, the money supply grew at a compound annual rate of 27 percent compared to 12 percent in 1960-72. This resulted in excess demand for goods and services as sluggish domestic production (real GDP grew at a compound annual rate of one percent in 1973-83) and expanded importation could not satisfy domestic demand sufficiently to keep prices stable.

The end of the oil boom came in 1981 as oil prices rose to historically high levels while demand for Nigerian crude sharply dropped. Since then the Nigerian economy has been in a steady decline, external indebtedness has risen sharply and government budgets have been in a continuing state of crisis. Exports fell from a peak of $27 billion in 1980 to an estimated $12 billion in 1984 and will be much lower in 1986 as a result of the sharp drop in oil prices. Imports have also fallen from a peak of $24 billion in 1981 to $11.5 billion in 1984 and expected to be lower in subsequent years. Outstanding long-term debt rose from under $4 billion in 1979 to $13 billion in 1983. The scarcity of foreign exchange has become a severe constraint to the growth of the Nigerian economy. Foreign exchange shortages have
resulted in an inability to import intermediate and capital goods needed to fully utilize and expand productive capacity.

As the economy deteriorated, the need for swift action to reverse the decline became evident. Some stabilization type measures—cutting public expenditures, delaying public investments, tightening private sector credit and strengthening import restrictions, were introduced. However, proposals by the IMF and World Bank for a maxi-devaluation of the Naira were rejected by successive governments. This led to an impasse between Nigeria and the IMF and the international financial community. During the three years of this standoff, Nigeria was denied normal access to international financial markets. In 1986 as the economic decline continued and crude oil prices plunged, the government embraced structural adjustment reforms. These reforms involve changes in the trade and exchange regime, a larger role for the private sector in the economy and liberalization of domestic and foreign trade related activities.

In September 1986, the government introduced the so-called second-tier foreign exchange market (SFEM) at which the exchange rate would be determined by the demand and supply of foreign exchange. This action led to a sharp devaluation of the Naira from a pre-SFEM rate of 70 US cent per Naira to as low as 20 cents. Although the government has taken this action, the debate on devaluation is far from dead. There remains a deep concern about the inflationary consequences of devaluation among policy makers and the public as well as serious doubts about the efficacy of devaluation and a flexible exchange rate policy in the Nigerian context. Unfortunately SFEM has been cast in many minds as the savior of the Nigerian economy, largely ignoring that it is only one
element of the reform package and that complementary policies as well as consistent and determined implementation of the reform package will be necessary for a successful program. Any perceived failure of the reform program will reinforce the doubts about devaluation and SFEM.

There is no denying, given the openness of the Nigerian economy, that devaluation will result in an increase in the price level in the short run. The key questions, however, are whether devaluation will result in runaway inflation, i.e., inflation that generates its own momentum, and whether it will result in relative price changes that lead to improvements in real economic activity. It is also important to look at the kind of policies that can complement devaluation and stabilize the price level as well as produce desirable real effects. Furthermore, it is useful to examine the impact of the absolute and relative price changes on the external balance and the distribution of income, investment and economic activity between the public and private sectors. In sum, decisions on adjustments to the exchange rate could involve consideration of tradeoffs between inflation, growth, distribution and external balance. This paper will attempt to shed some light on these issues.

II. THE MODEL

A macroeconomic model of Nigeria has to take into account the special characteristics of the Nigerian economy. These are i) the striking differences in sectoral production techniques and organization; ii) the dominant role of the oil revenues in both export and government revenues; iii) the instability of revenues from oil leading to instability of government revenues and the ability to import; iv) the
high dependence of the economy on imported capital and intermediate inputs; and v) the highly interventionist role of the government in money and financial markets, and in price and wage setting.

The differences in sectoral production techniques and organization manifest themselves in:

a) highly capital intensive and enclave nature of the hydrocarbon sector. Output and prices are determined by the world markets.

b) capital intensive, import dependent and import-substituting manufacturing sector. Characterized by existence of producer price controls and low capacity utilization due to the shortage of intermediate inputs.

c) capital using but labor intensive and import dependent services sector. A large trade and distribution sub-sector which initially developed from distributing imported goods. Activity in this sub sector historically provided opportunity for high rents due to producer price controls and over-valued exchange rates. Price controls in retail trade quite ineffective.

d) in agriculture, the dominant employer of labor, production is very labor intensive and dominated by small holders. Thus real producer prices of output are very important in eliciting higher labor supply and therefore higher output. Retail prices of output are generally market determined.

We attempt to incorporate these structural and policy induced rigidities into the macroeconomic model. The model is based on a consistent accounting framework, which implies that there is always overall balance or equality between supply and demand of factors and commodities. This however, does not always imply that markets clear in a competitive equilibrium sense. Disequilibrium arises from both the policy and structural rigidities. The model mainly uses stylized relationships in representing economic activities and the behavior of agents in the economy.
Following the above structural differentiation, the macroeconomic model has five types of production sectors, namely, agriculture, hydrocarbons, manufacturing, other industry and services.\(^1\) There are three types of economic agents -- private agents (households and enterprises), the government, and the rest of the world. There are two production factors, -- capital and labor. Accounting consistency in the model is achieved by the use of a social accounting matrix (SAM). The SAM has five accounts -- production, factors, institutions current, institutions capital, and the rest of the world. The use of the SAM facilitates the understanding of the flows of commodities through the various economic activities and agents and the implied financial flows.

Each production sector is assumed to produce a single commodity which can be sold as intermediate inputs to other producers, to individuals and government for domestic consumption, to other sectors as capital goods, and can be exported to the rest of the world. The receipts from the sales by the production sectors are then used to pay for intermediate inputs -- domestic and imported, to compensate factors of production, and to pay indirect taxes (less subsidies) to the government. These payments exhaust the value of total output, thus for each sector total receipts from sales equals total payments. In this

\(^1\) In the model actually employed there are nine production sectors, namely, agriculture, hydrocarbons (oil and gas), manufacturing, construction, other industry, transportation and communication, government services, wholesale and retail trade, and other services. The last four comprise the service sector in the above description.
case the payments to capital represent the operating surplus of the sector.

Total factor incomes available to be spent by the private sector (households and enterprises) is the sum of wages and operating surplus plus net factor transfers (profits and foreign wage income) from abroad. Enterprise income is distributed between the private sector and the government since the government also owns equity in enterprises.\(^1\)

Thus total private income is the sum of wage income, the private sector share of enterprise income, net current transfers from the government to the private sector (including interest payments on public sector debt) and net transfers from abroad. This income is exhausted by private consumption of domestic and imported goods and services, direct tax payments to state and federal governments, and private savings. Government income from direct and indirect taxes, enterprise income and non-factor transfers from abroad is similarly exhausted by expenditures on goods and services, transfers to the private sector and public savings.

On the capital account, the private sector derives its resources for investment from its savings; net capital transfers from the government, net new borrowing from domestic and foreign banks and the central bank, and net direct foreign investment. These resources are spent on private capital investment, acquisition of deposits from the banking sector and changes in the holding of domestic currency. The government derives its investible resources from its savings and

\(^1\) It would have been useful to separate public enterprises from the private sector but the availability of data on public enterprises precluded this.
borrowing from domestic and foreign banks and the central bank. It
spends on capital investment, capital transfers to the private sector
and acquisition of financial assets. The assets and liabilities of the
commercial banks and the central bank also are constrained to match.
For the central bank the sum of the assets - net lending to the private
sector, the government and the commercial banks equals the sum of the
changes in the private sector holding of currency and the changes in
international assets.

In presenting the model specifications, we will elaborate those
areas that are related to the issues of current interest -- relationship
between devaluation and prices, and the policies that affect this
relationship. We shall therefore concentrate on production, prices,
imports, exports, government revenues and expenditures and money
supply.\footnote{An outline of the core of the model is shown in Attachment 1.}

For each sector of production, we explain gross output and
prices, value added and their prices, and the demand for domestic and
imported intermediate inputs. In agriculture, value added is obtained
as a function of distributed lag of price of value added in agriculture
relative to the consumer price index (CPI). Output in the hydrocarbons
is exogenously given and manufacturing output is related to the
availability of intermediate inputs. Output in other industry is
exogenous. Value added in wholesale and retail trade is related to
domestic production of consumer goods as well as imports of consumption
goods. The value added in other services' sectors are related to total
domestic economic activity.
The model explains three types of prices - the consumer price index (CPI) and associated consumer goods price deflators, the value added or net production price deflators, and gross output prices. The CPI is the leading price index used in the model as it plays the role of a decision variable. All other prices are directly or indirectly linked to it. There is one wage index for the economy which is linked to the lagged consumer price index with an estimated elasticity of less than 1 (0.94). For the services sectors, value added prices are linked to this wage index. It is assumed that producers of services adjust their prices to improve their returns whenever wages are raised. The elasticity of adjustment differs by sector. However, for the wholesale and retail trade sector, both the net and gross production prices are assumed to vary to equalize total nominal product with total nominal demand derived with aggregate price deflators. Thus any influences that tend to delay the adjustment of sectoral prices to aggregate prices, for example, price and wage controls, will be reflected in changes in the prices of wholesale and retail trade.

For the commodity producing sectors -- hydrocarbons, manufacturing and agriculture, the following price adjustment is used. For hydrocarbons, the total output prices are determined by the aggregation of export and domestic prices of oil and gas. The export prices is exogenous and determined by the world market. The domestic price is exogenously set by the government. For the manufacturing sector, the price of imports and the economy wide wage index determine value added. A decline in import prices will tend to reduce the prices of import competing goods and vice versa. As agricultural prices are relatively free from government controls (except exports), the gross
output price is determined by demand and supply of agricultural goods. The value added price is then residually determined.

There are two factors that influence the CPI -- the price of imports of goods and contemporaneous and lagged money supply/real GDP ratios. The first reflects the direct impact of import prices and related exchange and tariff rates, while the second reflects the impact of excess money supply on the price level. Final goods prices are determined as a weighted average of net producer prices, and the prices of imported and domestic intermediate inputs. The exceptions are the gross and net output price of services in wholesale and retail trade which are obtained as residuals as described above.

Imports of goods are given in two broad categories, competitive and non-competitive imports. The former are foods and manufactured consumer goods, while the latter are intermediate inputs and capital goods. In determining competitive imports, three explanatory variables are considered. The first is the level of domestic activity, the second is the price of imports relative to the appropriate domestic price level, and the third is a measure of the ability to import. Capital goods imports are related to domestic investment with a fixed elasticity. Intermediate goods import is a function of lagged output in manufacturing (the predominant user) and the ability to import. It is assumed that Nigeria is a price taker in import markets. World prices of the imported commodities are converted to local currency by the exchange rate and adjusted for tariff rates.

Petroleum exports are given by the difference between production, which is exogenous, and consumption, which is endogenous. Exports of cocoa, palm kernels and palm oil are estimated as a
distributed (Almon) lags of producer prices relative to the consumer price index. Exports of other primary commodities and manufactures are small and are taken as exogenous. The export prices of all the commodities are taken as given by the world markets.

The fiscal sector of the model is fairly detailed but we discuss only the highlights. We consider two levels of government -- state and federal, and their sources of revenue and spending behavior. Most of the revenues are collected by the federal government and distributed between it and the states according to a constitutionally mandated formula. The major sources of revenue are oil, excise taxes and import duties. These revenues are derived endogenously as functions of oil production and prices, domestic production and imports. Personal taxes are related to household incomes.

Government revenues fluctuate as a result of the instability of revenues from oil, the dominant source of revenue. This instability coupled with the slow response of revenues to domestic tax changes, the thinness of the domestic capital market, and the somewhat limited access to international financial markets, force the government to adjust spending in line with its revenues. Nominal government current and capital expenditures are therefore expressed as functions of revenues plus autonomous components. To allow for the existence of finite speeds of adjustment in each case, the lagged dependent variable is included in the function.¹

¹/ This type of government behavior was used to model the government spending in copper dependent Zambia in Obidegwu and Nziramasanga (1981).
Individuals and firms hold currency, demand and time and savings deposits at commercial banks, and demand deposits at the central bank. Commercial banks and the central bank hold government bonds - thus finance the part of government deficits not met by foreign borrowing. The supply of high powered money is through changes in the holding of foreign assets by the banking system, central bank credits to the private sector, the government and to commercial banks less changes in commercial bank reserves. Private sector deposits at the central bank is taken as exogenous.

Given the supply of high powered money, individuals and firms decide on the allocation of their liquid assets between demand deposits, time and savings deposits, and currency. The proportion of demand deposit in broadly defined money supply (M2) is obtained as a function of the real deposit interest rate and a time trend. Similarly the proportion of time and savings deposits in M2 is a function of the ratio of nominal GDP and M2, the real deposit rate and a time trend. The currency held by the public is the sum of base money less the change in the reserves of the commercial banks at the Central Bank. These three relationships plus the broadly defined money supply identity simultaneously determine the money supply.

The model has a traditional aggregate consumption function in which private consumption is related to private disposable income, lagged consumption and the real money holdings (M1). The model is closed at the aggregate level, by the equality of savings (domestic and foreign) and investment although the structure of the model permits the alteration of closure rules as desired.
III. MODEL SIMULATION EXPERIMENTS

The task in this section is to use the model presented in the last section to look at the impact of exchange rates. The first action is to use the model to produce a baseline solution for the period 1981 to 1995. This solution is not to be interpreted as a forecast of the path of the Nigerian economy, but the exogenous values in the model have been chosen to yield a plausible path for the economy. The nominal exchange rate is exogenous and in the baseline solution, its evolution already implies some year to year devaluation. With a different sequence of nominal exchange rates implying deeper devaluations, we obtain an alternative solution to the model. The differences between the model variable values in the two cases give us the impact of the devaluations.

The alternative case assumes no policy response from the government and we refer to this situation as a passive policy stance. In most cases, the government takes some action. Thus we carry out further simulations assuming active policy response in the form of fiscal, monetary and trade policy changes. These solutions are compared to the passive policy case to determine the efficacy of these policies.

Before describing the model solution results, it is useful to examine how the model captures the transmission of inflation through exchange rate changes. The urban consumer price index (CPI) is the major price index in the model. Its evolution impinges on the decisions on labor and producer incomes. The CPI responds to changes in contemporaneous and lagged money supply/output changes and to changes in import prices in domestic currency. The estimated elasticity of the CPI
with respect to import prices is 0.45. This appears high but the urban 
CPI may be quite responsive to import prices as the consumption bundle 
is likely to be biased in favor of imported goods. It is also not 
unlikely that the CPI bundle may reflect the consumption of the middle 
and upper income urban dwellers which may be even more biased towards 
imports. In addition in an open economy with import substitution 
industries, the prices of domestically produced tradeable goods tend to 
be very responsive to the prices of competing imported goods.

Changes in nominal import and export prices do affect the money 
supply through foreign reserve behavior. If for example, a devaluation 
raises exports and lowers imports, there will be a build-up of 
reserves. In the absence of any countervailing actions, this will tend 
to raise the money supply. Devaluation will accentuate the impact of 
autonomous changes in net foreign assets on the money supply. For 
example, financing imports by reserve decumulation following a 
substantial devaluation will sharply reduce the money supply. Foreign 
borrowing by the central bank to finance imports will also have the same 
effect.

The results given by model simulation are short to medium term 
effects of devaluation and accompanying policies. Longer term impacts 
on resource allocation and its effects and the dynamic efficiencies 
resulting from devaluation and other policy changes are not addressed. 

There is no explicit treatment of capacity utilization and its impact on 
capital accumulation and the prices of labor and capital. The 
simulations assume the continued existence of slack in the economy over 
the simulation period; this slack is caused primarily by the scarcity of 
imported intermediate inputs in productive activity. The model, would
therefore not claim to have captured all the effects of devaluation and, in general, one would expect the model results to understate the positive effects of devaluation and complementary policies.

Case I: Devaluation and Passive Policy

This case contains a deep devaluation starting from 1986, of the naira against the US$, compared to the base case. The exchange rates for 1981 to 1985 remain as in the base. Table 4 shows the percent differences of the passive policy case from the base solution, for the nominal exchange rate (EXCHR) import prices (PM), and the consumer price index (CPI), and difference in the inflation rates ($\dot{P} = \Delta CPI/CPI(-1)$).

The results indicate that the CPI increases less than import prices implying a depreciation of the real exchange rate. Figs. 2a and 2b show the real exchange rate indices for exports (CPI over the weighted price index of non-oil exports) and for imports (CPI/PM) for both the base and passive policy cases. They both show a similar pattern with depreciation of the real exchange rate in the devaluation with passive policy case. Inflation, measured by the rate of change of the CPI, is generally higher in the devaluation case than in the base case; significantly higher in the first two years but the difference narrows appreciably afterwards. However, the trend path of the CPI in the passive policy case remains substantially above that in the base case.

The behavior of the CPI in the devaluation with passive policy can be explained by the evolution of government spending and the money supply. Government nominal expenditures respond to government revenues but some lag. Government budget deficits are partly financed by the
Table 4: PERCENT DIFFERENCES BETWEEN THE BASE AND THE PASSIVE POLICY CASE

<table>
<thead>
<tr>
<th>Year</th>
<th>EXCHR a/</th>
<th>PM</th>
<th>CPI</th>
<th>( \hat{p}_p - \hat{p}_b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>-30.0</td>
<td>41.8</td>
<td>13.5</td>
<td>15.4</td>
</tr>
<tr>
<td>1987</td>
<td>-55.5</td>
<td>122.3</td>
<td>34.3</td>
<td>20.3</td>
</tr>
<tr>
<td>1988</td>
<td>-50.0</td>
<td>98.0</td>
<td>30.2</td>
<td>-3.5</td>
</tr>
<tr>
<td>1989</td>
<td>-46.7</td>
<td>86.4</td>
<td>38.9</td>
<td>7.7</td>
</tr>
<tr>
<td>1990</td>
<td>-46.7</td>
<td>87.4</td>
<td>52.6</td>
<td>11.2</td>
</tr>
<tr>
<td>1991</td>
<td>-42.9</td>
<td>75.5</td>
<td>51.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>1992</td>
<td>-42.9</td>
<td>74.9</td>
<td>51.9</td>
<td>0.2</td>
</tr>
<tr>
<td>1993</td>
<td>-42.9</td>
<td>74.4</td>
<td>52.4</td>
<td>0.4</td>
</tr>
<tr>
<td>1994</td>
<td>-42.9</td>
<td>73.7</td>
<td>56.8</td>
<td>3.2</td>
</tr>
<tr>
<td>1995</td>
<td>-42.9</td>
<td>73.5</td>
<td>64.0</td>
<td>5.2</td>
</tr>
</tbody>
</table>

a/ Exchange rate and import prices do not change by the same percentage because the exchange rate is expressed in dollars per naira while import prices are in naira. Thus import prices would change by the change in the reciprocal of the exchange rate.

Central Bank, this raises the money supply. Maxi devaluation substantially raises nominal government revenues from petroleum sales and import duties. The lag in adjustment spending of spending to revenues implies that when revenue rises, the budget deficit is reduced which tends to reduce the money supply. However, there is an opposite tendency. As devaluation results in higher export revenues and lower import spending, ceteris paribus, there is a reserve buildup which would tend to increase money supply. The results indicate that, in the short-
Figure 2

COMPARISON OF BASE CASE WITH DEVALUATION UNDER PASSIVE POLICY

REAL EXCHANGE RATE INDEX (EXPORTS) 1985=100

REAL EXCHANGE RATE INDEX (IMPORTS) 1985=100

AGRICULTURE "TERMS OF TRADE" 1985=100

REAL GDP (BILLIONS)

BASE
DEVALUATION/PASSIVE POLICY
run, the first effect dominates the second, thus the impact of the increase in import prices on the domestic price level is somewhat mitigated by a decline in the money supply. Over the long run, the difference in the CPI between the base and the devaluation case increases as the government fully adjusts to its new and higher level of nominal revenues and imports catch up with the improvements in the availability of foreign exchange.

As most government income is derived from foreign trade related activities, devaluation results in a shift of income towards the government and higher government consumption and investment. Consequently there is a relative decline in private consumption and investment. Overall, real investment increases while total real consumption declines, as the marginal propensity to save by the government is greater than that of the private sector. In the short to medium-run, devaluation results in an improvement in the current account balance from improvements in the exports of agricultural commodities from substantially increased producer prices and a decline in the imports of food and other consumer goods.

Devaluation leads to a contraction of the gross domestic product in the short term but in improved performance in the medium term (see Fig. 2d). The short term contraction is due to decline in domestic consumption from the shifts of real income from the private sector to the government [a la Krugman and Taylor (1978)], a fall in agricultural production due to unfavorable short term relative price movements against agriculture (see Fig. 2c). In the medium term these unfavorable relative price movements are corrected and agricultural performance improves. In addition to the initial unfavorable relative
price movements, the slow response of agricultural production is also the result of lags in the adjustment to new agricultural prices. If the expectations formation can be speeded up (for example by dissemination of information), the adjustment period can be shortened and output will respond faster. In the medium term manufacturing output rises as a result of improved foreign exchange earnings. As investment spending increases, construction activity is stimulated.

In the longer term, the improvements of the real exchange rates and the agricultural terms of trade diminish, reducing the economic stimulus to growth in agricultural production for domestic and export markets (see Fig. 2). The overall impact is that the difference between the GDP in the base and devaluation case narrows that by 1995, the GDP is lower in the devaluation case. This result is consistent with the theoretical result that in the long run, devaluation does not affect the real exchange rate and therefore economic performance. To preserve the gains in relative price movements would call for another maxi devaluation. However this would result in the kind of devaluation-inflation spiral that was analyzed by Rodriguez (1978). The other option is to complement devaluation with macro policies that attack the excess demand fueled by expansionary government spending which is the underlying cause of recent inflation in Nigeria. We look at the latter option in the following section.

Case II: Devaluation and Active Policy

Devaluation results in a widening divergence between the price levels in the passive policy case and the base case. The appreciation of the real exchange rate decelerates as the price levels increases to
offset the impact of the devaluation. Domestic inflation also tends to
diverge from the baseline solution in the long run. The economic
stimulus of the devaluation -- increase in exports, agricultural
production, GDP, and the improvement of the current account, tend to
dissipate with time. Thus there is a need for policies to counteract
the inflationary impact and consolidate the stimulative effect of the
currency adjustments.

Monetary, fiscal, and trade policies would be appropriate, in
the Nigerian context, to counteract the inflationary consequences of the
devaluation of the currency. Wage restraints are necessary to make
devaluation effective. Wage policies, however, raise complex political,
income distribution and equity issues that this macroeconomic model
cannot shed light on. Besides, wage determination is best left to labor
markets so there is nothing to be gained by showing model simulations of
using wage policy to fight inflation. We simply assume that past wage-
price relationships will be maintained. Thus this exercise will
concentrate on monetary, fiscal and trade policies.

Monetary and fiscal policies are inter-related as the Central
Bank is the major lender, as well as the lender of last resort to the
government. Because of this strong inter-relationship one simulation
should be sufficient to demonstrate the efficacy of each in reducing
inflation. In this simulation then we apply autonomous reductions in
government current and capital expenditures in each year starting in
1988, two periods after the initial devaluation. Table 5 shows the
percent differences of the active fiscal policy case from the passive
policy case for real government consumption and capital expenditures
Table 5: PERCENT DIFFERENCES BETWEEN THE PASSIVE POLICY AND THE ACTIVE FISCAL POLICY CASES

<table>
<thead>
<tr>
<th>Year</th>
<th>EXCHR</th>
<th>GC</th>
<th>GEXP</th>
<th>MS2</th>
<th>CPI</th>
<th>( \hat{p}_p - \hat{p}_a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1987</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.2</td>
<td>-0.3</td>
<td>-0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>1988</td>
<td>0.0</td>
<td>-12.6</td>
<td>-7.0</td>
<td>-18.0</td>
<td>-3.4</td>
<td>-3.6</td>
</tr>
<tr>
<td>1989</td>
<td>0.0</td>
<td>-12.5</td>
<td>-4.3</td>
<td>-14.1</td>
<td>-5.8</td>
<td>-3.1</td>
</tr>
<tr>
<td>1990</td>
<td>0.0</td>
<td>-10.2</td>
<td>-4.3</td>
<td>-12.3</td>
<td>-7.5</td>
<td>-2.1</td>
</tr>
<tr>
<td>1991</td>
<td>0.0</td>
<td>13.5</td>
<td>-4.3</td>
<td>-22.9</td>
<td>-10.3</td>
<td>-3.6</td>
</tr>
<tr>
<td>1992</td>
<td>0.0</td>
<td>-14.1</td>
<td>-0.7</td>
<td>-44.3</td>
<td>-17.0</td>
<td>-8.4</td>
</tr>
<tr>
<td>1993</td>
<td>0.0</td>
<td>-13.2</td>
<td>+6.3</td>
<td>-38.3</td>
<td>-21.3</td>
<td>-6.0</td>
</tr>
<tr>
<td>1994</td>
<td>0.0</td>
<td>-9.8</td>
<td>7.6</td>
<td>-34.1</td>
<td>-23.0</td>
<td>-2.4</td>
</tr>
<tr>
<td>1995</td>
<td>0.0</td>
<td>-5.3</td>
<td>6.2</td>
<td>-31.8</td>
<td>-22.1</td>
<td>1.3</td>
</tr>
</tbody>
</table>

\( \hat{p}_p \) = inflation in the passive policy case.
\( \hat{p}_a \) = inflation in the active fiscal policy case.

(GEXP), nominal money supply (MS), and consumer price index (CPI), and the differences in the inflation rates (\( \hat{p} \)).

In this simulation, real government consumption expenditure (GC) was constrained to be equal to the base case and the growth of nominal capital expenditures was restrained.\(^1\) Total real spending (GEXP) remains below the passive policy case in the medium term but in

\(^1\) The value was not set exogenously but an exogenous factor was introduced to keep the nominal expenditures lower than in the passive policy case.
the longer term GEXP grows faster as a result of higher real government investment. The overall reduction of nominal government expenditures result in lower money supply, lower CPI and generally lower inflation, further depreciations of the real exchange rates and slight improvements in the agricultural terms of trade (see Fig. 3c).

The reduction in government expenditures cuts the projected budget deficits in the policy case by about a half leading to lower level of financing from the Central Bank. The end result is lower money supply and lower inflation. The favorable relative price changes lead to expenditure cuts and lower prices higher growth in agriculture, particularly exportables, and manufacturing, as a result of the greater availability of foreign exchange and GDP growth is higher (see Fig. 3d). Investment is higher, with a greater private sector component, as reduced government spending frees resources to be spent by the private sector. The current account balance also improves.

A model simulation was carried out by a direct monetary policy action without any fiscal policy adjustments. The flow of net lending by the Central Bank to the private non-bank sector was reduced. The impact of this is a reduction of the money supply and low inflation but the changes were small because the flows are small. While the Central Banks carries out transactions with the commercial banks, the government, non-resident entities and the non-bank private sector, the volumes of transactions with the private sector and the commercial banks are historically small compared to those with the government. This limits the scope of the use of these transactions for effecting macroeconomic actions.
Figure 3

COMPARISON OF DEVALUATION UNDER PASSIVE POLICY WITH ACTIVE POLICY SIMULATIONS

REAL EXCHANGE RATE (EXPORTS) 1985=100

REAL EXCHANGE RATE (IMPORTS) 1985=100

AGRICULTURE "TERMS OF TRADE" 1985=100

REAL GDP (BILLIONS)

DEVALUATION/PASSIVE POLICY
DEVALUATION/FISCAL POLICY
DEVALUATION/TRADE POLICY
Model simulations were done by reducing the import tariffs on consumer, investment and intermediate goods. Table 6 shows the impact of the tariff reductions on selected variables -- import prices (PM), CPI, inflation ($\hat{p}$).

**Table 6: TARIFF REDUCTIONS: DIFFERENCES BETWEEN THE PASSIVE POLICY CASE AND THE TARIFF REDUCTIONS CASE**

<table>
<thead>
<tr>
<th>Year</th>
<th>PM</th>
<th>CPI</th>
<th>$\hat{p}_p - \hat{p}_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>-4.2</td>
<td>-2.5</td>
<td>-3.2</td>
</tr>
<tr>
<td>1987</td>
<td>-7.1</td>
<td>-5.4</td>
<td>-3.9</td>
</tr>
<tr>
<td>1988</td>
<td>-7.3</td>
<td>-7.3</td>
<td>-2.2</td>
</tr>
<tr>
<td>1989</td>
<td>-7.5</td>
<td>-7.8</td>
<td>-0.6</td>
</tr>
<tr>
<td>1990</td>
<td>-6.4</td>
<td>-8.2</td>
<td>0.5</td>
</tr>
<tr>
<td>1991</td>
<td>-8.9</td>
<td>-9.2</td>
<td>-1.4</td>
</tr>
<tr>
<td>1992</td>
<td>-9.1</td>
<td>-10.3</td>
<td>-1.3</td>
</tr>
<tr>
<td>1993</td>
<td>-9.4</td>
<td>-11.6</td>
<td>-1.7</td>
</tr>
<tr>
<td>1994</td>
<td>-9.8</td>
<td>-12.4</td>
<td>-1.0</td>
</tr>
<tr>
<td>1995</td>
<td>-10.3</td>
<td>-12.5</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

* $\hat{p}_p$ = Inflation with devaluation on -- passive policy
  $\hat{p}_t$ = Inflation with devaluation and trade policy

With tariff reductions both the price level and inflation move in the desired direction. In addition tariff reductions give a big boost to agricultural exports and agricultural production in general as relative prices move in favor of exports and agriculture (see Fig. 3). The production of manufactures also benefit from the improved availability of imported inputs made possible by higher exports.
Wholesale and retail trade as well as other service sectors also benefit from increase in activity in the commodity producing sectors. GDP is boosted as a result. Thus cuts in tariffs with devaluation lead to a mitigation in the devaluation induced inflation as well as stimulating economic activity.

IV. CONCLUSIONS

With simulations from the model we have shown that the devaluation of the exchange rate raises the price level and inflation on average but the proportional increase in the price level remains below the proportional increase in import and export prices. Thus the nominal devaluation is generally effective in producing real depreciation of the exchange rate over several time periods. However the magnitude of the real depreciation tends to diminish with time. The induced depreciation of the real exchange rate produces some positive impact on economic performance. Agricultural production is stimulated along with agricultural exports. The balance of payments shows some improvement. But as the depreciation of the real exchange rate diminishes, with the increasing rise of the domestic price level, the positive effects of the devaluations tend to dissipate.

We further carried out model simulations aimed at restraining the domestic price level with fiscal, monetary and trade policies. These simulations show that fiscal restraint, in the face of increasing nominal revenues from the devaluation, and tariff reductions are effective tools to counter the inflationary impact of devaluation and thus preserving and strengthening the gains from the devaluations.
Fiscal policy affects major monetary aggregates and a reduction in the budget deficit reduces the financing requirements to be met by the Central Bank and therefore the money supply. Fiscal restraint also serves to limit the distributional impact of the devaluation — the tendency of a devaluation to distribute income towards the government. The result of fiscal restraint is that more real credit is available to the private sector and thus greater private investment. A simulation was carried out by restraining money supply growth through reductions in the credit of the Central Bank to the private sector. The impact was in the expected and right direction but as the volume of transactions involved has traditionally been small, the effect was small.

Reductions in tariffs from an average rate on imported goods of 30 percent to 15 percent was effective in countering the inflationary impact of the devaluation. In addition, tariff reductions mitigated the distributional impact of the devaluation by reducing government revenue and increasing private disposable income. This resulted in increases in private consumption and investment. Tariff reductions also moved relative prices in favor of exports and thus generated an increase in agricultural exports. Import prices reductions stimulated imports but the overall effect was an improvement in the current account of the balance of payments. Relative prices also moved in favor of agriculture and stimulated agricultural production and GDP.

Nigeria has now embarked on a policy of a more flexible exchange rate with the introduction of the second tier foreign exchange market (SFEM). This has already resulted in deep devaluations of the naira. This new policy stance will need to be backed up by restraint in fiscal and monetary policies as well as changes in trade policies —
tariff reductions, removal of quotas and import bans. Institutional changes may be required to facilitate the use of fiscal and monetary policy tools.

Under current fiscal arrangements, it should be difficult to produce the magnitude of fiscal restraint required because of the constitutionally mandated revenue sharing arrangements. Co-ordination of fiscal policy between the federal and the 19 state governments is not easy and the federal government will not be able to undertake the full magnitude of cuts required to keep inflation low.

This limited flexibility in fiscal policy would call for a more active and independent monetary policy. In the short run, monetary policy will not do the job because the volume of central bank transactions with the domestic non-government sector is low compared to its transactions with the government. In addition, commercial banks have traditionally maintained excess liquidity (see Masha, R. A., 1983). This implies that any marginal changes in required liquidity ratios may have little impact on bank credit creation as the required liquidity constraints may not be binding. Control of the volume and sectoral allocation of commercial bank lending has been the major tool used by the Central Bank to control the money supply; this may not be consistent with the new liberal policy framework.

Institutional changes in the operation of monetary policies are therefore needed to give the Central Bank the capability and flexibility to regulate monetary aggregates. Reserve or liquidity requirements of the commercial banks could be tightened so that they can be used to regulate the activities of commercial banks. The composition of assets that meet reserve requirements, for example the inclusion of some
government securities, needs to be reviewed with a view to facilitate regulation of credit creation. The structure of interest rates, as well as the necessity for the Central Bank control of interest rates and credit need to be re-examined for consistency with the policy of flexible exchange rates. The activities of non-commercial bank financial institutions ought to be brought under the purview of more stringent Central Bank regulation. The Central Bank should expand the availability of government securities to the non-bank sector so that open market operations can become an effective tool of monetary policy. The reduction of the availability and desirability of government securities to the commercial banks would make them more aggressive in seeking other earning assets.
OUTLINE OF THE CORE OF THE MODEL

Below we present the major relationships in the model in the production, prices, imports and exports, government sector and money.

PRODUCTION

There are five production sectors in the model -- agriculture, hydrocarbons, manufacturing, other industry and services. Each of the sectors has its own unique production possibility. For sector $j$, $Y_j$ denotes value added at constant factor cost, $Q_j$ is gross output, $PV_j$ is value added prices, $A_{ij}$ is an input-output coefficient, $M_j$ is imported inputs per unit of output, and $INDT_j$ is indirect taxes less subsidies paid by sector $j$. The relationship between gross output $Q_j$ and value added $Y_j$ is given by

$$Q_j = Y_j + \sum_{j=1}^{\infty} A_{ij} * Q_j + M_j * Q_j + INDT_j$$

AGRICULTURE $Y_1$, the value added in agriculture is determined by the value added prices in agriculture $PV_1$ relative to the consumer price index (CPI).

$$Y_1 = f(PV_1/CPI)$$

1/ For a full description of the model see Obidegwu, C; A Macroeconomic Model of the Nigerian Economy (mimeo); the World Bank, 1986.
This relation was estimated with a distributed Almon lag.

**HYDROCARBONS** Output $Q_2$ is taken exogenously.

$$Q_2 = \overline{Q}_2$$

**MANUFACTURES** Output, $Q_3$ is given by a fixed coefficient production with imports of intermediate inputs as the limiting input. As the available data does not permit the estimation of this relation the coefficient was chosen using the base year data.

$$Q_3 = \frac{\text{MINTM}}{M_3}$$

where MINTM is the available intermediate input imports available to the manufacturing sector, and $M_3$ is the imported intermediate input per unit of output.

**OTHER INDUSTRY AND SERVICES** Construction output is determined by public and private investment. Other minor industry are exogenous. Value added in wholesale and retail trade is related to the domestic production of consumer goods and imports of consumption goods. Other services value added are functions of the level of economic activity (GDP).

**PRICES**

The major price level indicator is the urban consumer price index (CPI). For each sector there is an associated gross output price
P\_j$, value added price $PV\_j$, and imported intermediate input price $PIM\_j$.

There is one wage index $W$, the aggregate import price is $PM$, and the broadly defined money supply is $MS$.

The CPI is obtained from an estimate of the reduced form price formation relationship:

$$\text{CPI} = f(\text{PM}, \text{MS}/\text{GDP})$$

This relation was estimated with distributed lags of $\text{MS}/\text{GDP}$.

The wage index is related to the CPI, with the possibility of lagged reactions.

$$W = f(\text{CPI})$$

The relationship between gross output prices $P\_j$ and value added prices $PV\_j$ for sector $j$ is

$$P\_j = \frac{1}{(1-t\_j + S\_j)} \times \sum_{l=1}^{n} A\_l \times P\_l + M\_j \times PIM\_j + PV\_j \times V\_j$$

where $n$ = number of production sectors, $V\_j$ is the value added by unit of gross output, $t\_j$ and $S\_j$ are the excise tax and subsidy rates per unit of output respectively in sector $j$. For the agriculture sector $P\_j$ is determined by the equality of demand and supply for agricultural goods, thus $PV\_j$ is derived residually using the above relationship. For the hydrocarbon sector, $P\_j$ is a weighted average of export and domestic prices of hydrocarbons. The export prices are given by world markets while the domestic prices are exogenously set by the government. As for agriculture $PV\_j$ is derived residually. Manufacturing sector value added
price \((PV_3)\) is obtained as a function of the wage index and the price of import of goods.

\[ PV_3 = f(W, PMG) \]

For the other sectors the value added or net output prices are obtained as functions of the wage index.

It is assumed that Nigeria is a price taker in world markets for its importables and the world price index of commodity \(i\) is \(PMW_i\). The corresponding landed price index (ex-port) in domestic currency is given by

\[ PMD_j = PMW_j * \frac{e_0}{e} * \frac{(1+tf_j)}{(1+tf_j0)} \]

where \(e_0, e\) are the base and current year exchange rates respectively in foreign currency per naira, and \(tf_j, tf_j0\) are tariff rates on commodity \(j\) in the current and base years respectively.

**IMPORTS**

There are two broad categories of imports -- competitive and non-competitive imports. The former are foods and manufactured consumption goods and the latter are intermediate inputs and capital goods. All imports are constrained by the perceived availability of foreign exchange. The availability is influenced by the export performance of the previous period \(X_{t-1}\) and the beginning of period reserves \(RES_{t-1}\). The ability to import \(IMPCAP\) is defined as follows:
IMPCAP = \( \frac{(X_{t-1} + RES_{t-1})}{PM} \)

The imports of non-competitive goods (MN\(_j\)) are related to an activity variable ACT\(_j\) and the ability to import

\[ MN_j = f(ACT_j, IMPCAP) \]

For capital goods the corresponding activity variable is gross fixed investment while for intermediate inputs the activity variable is value added in industry lagged one period.

For competitive inputs relative prices play a role.

\[ MC_j = f(ACT_j, PMD_j/P_j, IMPCAP) \]

The income variable (ACT\(_j\)) for both agricultural and consumer goods imports is GDP corrected for terms of trade changes.

**EXPORTS**

There are four groups of exportables -- agricultural commodities, hydrocarbons, of which crude oil is dominant, manufactures and services. It is assumed that Nigeria is a price taker in world markets such that the export price (PX\(_i\)) of commodity \( i \) received by the export agency is the world price of the commodity converted by the ruling exchange rate.

For major agricultural commodities -- cocoa, palm produce, the supply of exports are estimated as functions of contemporaneous and lagged real producer prices (PPX\(_i\)) using a distributed lag procedure.
\[ X_i = f(PPX_i/CPI, Z) \]

\( Z \) is any other variable that influence those exports, for example domestic consumption of the commodity. As this is not usually available, it is proxied by total domestic consumption. The producer price (\( PPX_i \)) until recently was determined by a marketing board. \( PPX_i \) is taken to be related to \( PX_i \) follows

\[ PPX_i = k_i \cdot PX_i \]

where \( k_i \) is a policy variable. When producer prices are equal to border prices \( k_i = 1 \). If \( k_i < 1 \), then producers are taxed and if \( k_i > 1 \), producers are subsidized.

For hydrocarbons, exports are given by the difference between production (\( Q_z \)) in barrel equivalents of oil per day and domestic consumption (\( Q_c \)) of hydrocarbon products in the same units:

\[ X_2 = Q_2 - Q_c \]

\( Q_c \) is obtained as a function of GDP and relative prices

\[ Q_c = f(GDP, P_2/CPI) \]

where \( P_2 \) is the government controlled price of crude oil sold to domestic refiners.

The exports of manufactures, minor agricultural products, and services are held exogenous.
GOVERNMENT EXPENDITURES AND DEFICITS

Government current expenditures are modelled as functions of revenues and government capital expenditures is determined by the excess of revenues over current expenditures (current savings). To allow for the existence of finite speeds of adjustment, the lagged dependent variable is included in the function. If GDXP is current expenditures on goods and services, REV is total government revenues, IGX is capital expenditures and GSAV is current government savings then

\[
GEXP_t = G1 \times REV_t + G2 \times GEXP_{t-1} + G3
\]

\[
IGX_t = G4 \times GSAV_t + G5 \times IGX_{t-1} + G6
\]

G3 and G6 are autonomous spending components.

The overall government budget deficit is given by

\[
GOVDEF = REV - GEXP - IGX - GVNL
\]

where GVNL is government capital transfers to other sectors of the economy less repayments. The deficit is financed by the Central Bank, foreign borrowing and financial institutions, mainly commercial banks. The Central Bank financing of the deficit is given by

\[
DCGOV = \alpha_0 + \alpha_1 \times GOVDEF
\]

The rest of the deficit is financed by foreign borrowing and financial institutions. For a given level of foreign financing, an increase in
the budget deficit would not only increase the central bank financing of the deficit but would also increase the contribution of the financial institutions and thus reduce the credit available to the private sector. This approach of characterizing the financing of the deficit is one way that it can be done. There are other approaches. One could postulate that for portfolio considerations, the commercial banks and other institutions can absorb only a certain amount of the deficit in a given period. The residual would then have to be financed by foreign borrowing and the Central Bank. In the former approach, \( a_0 \) and \( a_1 \) can be regarded as exogenous policy parameters which can be varied by the Central Bank to regulate the monetization of the deficit.

**MONEY SUPPLY**

The Central Bank supplies high powered money through monetization of government deficit (DCGOV), credit to financial institutions (DCFIN) and the private sector (DCPRI), and change in the holdings of foreign assets (DFORASS). The change in the monetary base (DMB) is given by

\[
DMB = DCGOV + DCFIN + DCPRI + DFORASS
\]

The money supply is determined by how the public allocates its liquid assets between currency holdings (CURR) demand deposits (DD), and time and savings deposits (TSD). The proportion of demand deposits in broadly defined money supply (M2) is a function of a time trend and the real interest rate on time and savings deposits. Similarly the
proportion of time and saving deposits in M2 is a function of the ratio of GDP in current prices to M2, a time trend and the real deposit interest rate.

\[
DD/MS = f(t, DEPR - CPI)
\]

\[
TD/MS = f(GDPCUR/MS, t, DEPR - CPI)
\]

Currency held by the public and MS are given by

\[
CURR_t = CURR_{t-1} + DMB - CBRES
\]

\[
MS_t = CURR_t + DD_t + TD_t
\]

DEPR is the deposit rate on time and saving deposits, CPI is the CPI based inflation rate and CBRES is currency reserves held by commercial banks. The above equations simultaneously determine the money supply (MS).
REFERENCES


