Macroeconomic adjustment, trade and growth: Policy analysis using a macroeconomic model of Nigeria

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Abstract

This research paper presents a medium-sized macroeconomic model of the Nigerian economy that incorporates both forward-looking, model-consistent expectations and, backward-looking, adaptive expectations in the assets and goods markets. The model is designed for use in evaluating alternative policy regimes under the structural adjustment programmes in Nigeria. It is shown to have sensible short- to medium-term simulation properties, and can be applied to analysis of a wide range of policy issues of the 'what if' kind. In this report, only demonstrative simulations are run to shed light on the implications of alternative expectations regimes, and domestic monetary and fiscal policies under SAP for Nigeria's trade performance and growth prospects in the 1990s. It is shown that key proposals for 'fiscal discipline' and enforcing a regime of 'stabilization with sterilization' in respect of windfalls from oil exports are consistent with the other SAP objectives of promoting macroeconomic stability, trade and growth in the medium and long runs.

I Introduction

Introduction/statement of the problem

Macroeconomic stability and growth are the two principal objectives of the World Bank/IMF supported Structural Adjustment Programmes (SAP). These programmes constitute a logical response to the debt and development crises experienced by most of the developing countries, especially since the early 1980s. The specific contents of the programmes, the choice of instruments and the timing and sequencing of the implementation depend or should depend on the stage of development of a country's economic institutions, the size of its debt burden, the nature of the existing macroeconomic imbalances and policy distortions and political sensitivities. In a broad sense, the programmes often involve the integration of traditional short-term stabilization essentially the correction of external and internal imbalances through aggregate demand management with medium to longer-term structural measures aimed at stimulating the supply side of the economy.

The basic elements of the programmes generally involve:(i) Monetary restraint aimed at reducing the growth of absorption and the rate of inflation; (ii) Interest rate policies aimed at keeping real interest rates positive but low; (iii) Fiscal restraint to reduce the fiscal deficit to a sustainable level and thereby restrain aggregate demand pressures; (iv) Exchange rate action to ensure a real exchange rate that improves international competitiveness and creates the incentive for expanding the production of internationally traded goods; (v) External financing policies to reduce the stock of external debt if it is perceived to be currently unsustainable, or to limit foreign borrowing if it is likely to become so in the future; (vi) Structural reforms (such as financial sector reforms, producer pricing policies, trade liberalization, and tax reforms) to make the economy flexible and efficient[1].

About 30 countries in Africa began implementing SAPs in the early 1980s. Their experiences have varied, depending on the peculiar structure of the economy, and the nature of their macroeconomic imbalances. In Nigeria, for instance, the results of SAP policies since their introduction in 1986 have not been salutary. In spite of the conscious efforts to implement most aspects of the basic elements of SAP as outlined above, Nigeria's external debt has increased from about $18 billion in 1986 to over $33 billion in 1992. Government's annual budget-deficit has exceeded 10% of GDP, price inflation has been very high, and capacity utilization has been very low even though the annual growth rate of GDP has been modest. Controversies have raged among policyanalysts

and policymakers as to what went wrong, and what other viable macroeconomic policies could be implemented to ensure the success of structural adjustment. In the course of the debates, and in the light of the structure of the economy, the nature of external shocks that affect it and the results of the adjustment process so far, certain issues and questions have been raised about the prospects of SAP policies in Nigeria:

1. Given the nature of such external shocks, the structure of the Nigerian economy and its fiscal federalism, can the government realistically avoid persistent budget deficits without sacrificing the growth objectives of the adjustment programme?

2. In view of the institutional practice of active monetization of foreign exchange earnings, persistent budget deficits in the face of rising debt interest payments and moderate current account surpluses, can the Central Bank of Nigeria successfully control money supply and inflation, and hence stabilize the exchange rate? Are there significant crowding-out effects of the public sector deficit financing on the private sector?

3. To what extent can the liberalization of the foreign exchange market, and thus the expenditure-switching effects stemming from exchange rate changes, reduce the stress on the current account and also boost the non-oil export sector? Furthermore, given the structure of Nigeria's tradeable goods sector, what are the prospects of the external sector (mainly exports) leading the economy to sustainable growth in the medium to long-term?

4. In the absence of debt forgiveness or equivalent operations, and in the face of declining oil prices, are the present adjustment processes sustainable in terms of ensuring macroeconomic stability with growth even in the long run? Or are the basic elements of stabilization and liberalization in conflict, therefore requiring, as Sachs (1987) argues, 'different sequencing and timing procedures between stabilization and liberalization measures'?

5. What other structural and institutional reforms should the government embark on to aid a 'growth-oriented-adjustment' process?

The foregoing are certainly issues and questions that are central to a critical evaluation of the on-going adjustment efforts in Nigeria. Such an evaluation exercise, or even the design of the adjustment programme for that matter, needs a formal model framework, either implicitly or explicitly. An explicit, formal model framework, in spite of its shortcomings, is preferred to implicit models. A quantitative model, for instance, not only provides a theoretical structure for understanding the linkages among principal macroeconomic variables but also provides, in broad order of magnitudes, a systematic

sense of the signs and magnitudes of the relevant parameters and the transmission of shocks from one sector to others and the feed-back effects to the originating sector. In essence, the dynamic properties of the adjustment process can be meaningfully studied with formal models.

This study is therefore motivated by two driving needs. The first is the absence of an operational macroeconomic model of the Nigerian economy that captures the current SAP environment. A major objective of this research is to develop such a model. The second need is to use the model to evaluate the internal consistency of some of the proposals for fiscal and monetary discipline in Nigeria. In particular, we use some standardized shocks to evaluate the potentials of budget-deficit reduction policy in promoting macroeconomic stability, trade and growth in the short and medium runs. Also, the implications of a positive oil price shock under a regime of stabilization with sterilization are evaluated. This is designed to shed light on the consistency of the proposals for oil stabilization account and sterilization of oil windfalls with the objectives of SAP in Nigeria.

Objectives of the research agenda

The basic, short-run goals of the research agenda are to build and maintain a general-equilibrium economic model of the Nigerian economy that captures the essential elements of the current SAP environment in Nigeria. Over the medium and longer-runs, the model is to be maintained alongside, and used interactively with, some global models (such as the IMF's MULTIMOD) so as to permit the simulation of the dynamic paths of the external shocks that affect the Nigerian economy. The Nigerian model, together with its ad hoc linkages to the global models, is to be maintained for policy analysis of the Nigerian economy, and could be applied to illuminate a variety of important policy issues. Over a longer-run, global empirical models such as MULTIMOD will be further refined. It will ultimately be desirable to disaggregate MULTIMOD's current developing country region (DC) into several separate developing country regions, including an African region. The more progress that is made in successfully disaggregating the MULTIMOD DC region, the more it will be possible to refine estimates of the linkages between the Nigerian economy and the rest of the world. Alternatively, the Nigerian model may provide an important starting point toward a future construction of a sub-regional model of the Economic Community of West African States (ECOWAS) or even an African regional model.

The specific objectives of the present research are:

1. to build a medium-sized macroeconomic model of the Nigerian economy that captures the basic elements of the SAP policy environment to verify the model's consistency and statistical properties, and to simulate it under alternative assumptions

about the expectations formation process of private economic agents in Nigeria (adaptive and model-consistent expectations).

2. to use standardized shocks that are consistent with various fiscal and monetary policy proposals under SAP to shed light on the implications of these proposals for Nigeria's trade, economic growth and macroeconomic stability in the short and medium runs.

3. to make policy recommendations on the basis of the simulation results.

Overview of major macroeconomic trends during the SAP regime in Nigeria

For several years prior to the introduction of SAP policies in 1986, the Nigerian economy was in deep crisis. This was precipitated mainly by the collapse of the oil prices and the gross mismanagement of the economy in general. The oil boom era of the of mid 1970s to 1980 witnessed a massive expansion in the size of government and most of the oil revenues were spent to expand physical infrastructure; finance increases in recurrent expenditures resulting mainly from the sharp rise in wages and salaries, expansion of the import-based consumer goods industry and import-substitution industrialization programmes; and inefficient and sometimes bogus manufacturing industries. The policy direction also led to the deterioration of the agricultural sector and non-oil export sector, and maintained a highly overvalued exchange rate. Price controls were generally enforced and both quantitative and tariff-based import restrictions were frequently applied to correct perceived imbalances in the current account.

Following the collapse of the oil prices, export receipts declined from $26 billion in 1980 to $9.4 billion in 1989. In real terms, oil export revenues fell below their pre-oil boom era, and the resulting external and fiscal imbalances became unsustainable. The current account deficit reached 6% of GDP in 1983, and the fiscal deficit was double that figure. Between 1981 and 1986, real aggregate demand fell by 35%. The situation continued to worsen and in 1989, per capita GDP had dropped to around $250 compared to $1090 in 1980. During the oil boom era, the major mechanism of government's patronage was public expenditure; during the slump this source was replaced by rents from foreign exchange allocation. An indication of the growth in such rents and from the implicit tariff rates generated by import restrictions can be obtained by examining the parallel market premium over the official rate. In early 1981, this premium was only 37%; during 1983 it exceeded 200% and by 1986 it was 330% (Bevan, et al, 1992:23). No doubt this policy reduced the income of the export sector - a cumbersome and

rationed access to imports was imposed - and thus handicapping firms that depended on imported inputs. It was obvious to policy analysts that urgent policy responses were needed but up to the mid-1980s, there was no consensus as to what should be done.

When the Babangida regime came into office in August 1985, it was faced with even deeper economic crisis. Oil prices crashed to their all-time low level, and by the time the government had spent one year in office, real income had fallen by more than 20%, an unprecedented decline even by the harsh standards of the preceding years. The inevitability of a fundamental economic restructuring policy response became urgent and the Babangida regime embarked on the World Bank/IMF supported structural adjustment programme in September 1986. The most important elements of the adjustment programme were:

* abolition of the import-licensing regime and the liberalization of the foreign exchange market;

* rationalization and restructuri..g of tariffs in order to aid industrial diversification;

* introduction of measures to stimulate domestic production and broaden the supply base of the economy;

* deregulation of the monetary and financial system while aiming to maintain tight control over budgetary deficits;

* substantial liberalization of trade and payments;

* adoption of appropriate pricing policies, especially for petroleum products and public enterprises; and,

* encouragement of rationalization and privatization of public sector enterprises.

It is one thing to articulate sound economic policies; it is another to effectively implement them. Effectiveness in the implementation of specific adjustment programmes by the government is crucial in determining general economic performance. This is especially true in the peculiar circumstances of such economies as Nigeria, where the public sector is the dominant economic agent. The mainstay of the economy - the oil sector - is owned by the federal government and accounts for over 90% of Nigeria's foreign exchange earnings and over 70% of government revenues, and represents about 13% of the GDP. Almost all of Nigeria's external debts are the obligations of the federal government, with a large proportion owed to external private creditors at variable interest rates. Nigeria is a price taker in both the oil and the primary commodity (agricultural export) markets. In the case of oil, the quantity of output is also exogenously determined

by OPEC. These characteristics of the public sector have important implications for the success of the adjustment process.

Table 1: Some economic and financial indicators

	GDP %	Ex. Rate Naira/ US$	Inflation	Lending rate (prime)	Mini. rediscount rate	M1%	GOV. TOT	CBN/ GOV	DDBT %
1986	3.13	1.73	5.40	17.50	10.00	5.23	0.53	0.85	1.79
1987	1.70	3.97	10.20	20.50	13.86	13.70	0.53	0.73	29.31
1988	4.20	4.54	38.30	18.40	12.75	41.90	0.52	0.84	27.83
1989	5.20	7.37	50.50	25.70	18.50	21.51	0.41	0.92	21.31
1990	5.20	8.35	7.50	26.50	18.50	44.90	0.45	0.80	47.40
1991	4.60	10.87	13.00	21.00	15.50	32.60	0.46	0.89	38.20
1992	4.10	19.47	44.60	31.20	17.50	66.40	0.52	0.87	39.00

Sources: Computed from Central Bank of Nigeria's *Annual Report and Statement of Accounts* (various years)

CBN's *Statistical Bulletin, 1992*

Notes:

GDP   = Growth rate of GDP
CBN   = Total credit granted by the Central Bank of Nigeria
DDEBT = Domestic debt of the Federal government (growth rate)
TOT   = Total credit to the domestic economy by the banking system

A review of some economic indicators shows that the adjustment programme has had mixed results in Nigeria. As Table 1 shows, the annual growth rate of the GDP (at 1984 constant factor cost) has been modest, recovering from a mere 1.7% in 1987 to an average annual growth rate of over 4% since 1988. This appears an impressive performance especially when the general macroeconomic instability occasioned by government's fiscal and monetary policies is considered. For example, as is evident from Table 1, the government has not been successful in controlling the growth rate of money stock and consequently the inflation rate has been quite high over the years. The narrow money stock has been growing quite rapidly, reaching an unprecedented high rate of 66% in 1992. These increases in monetary aggregates are often blamed on the unsustainably high rate of monetization of foreign exchange earnings of the public sector and the sharp rise in credit to the domestic economy. High growth in credit to the domestic economy was attributed to the huge federal government deficit, which was mainly financed by the Central Bank of Nigeria. The federal government's budget deficit has been around 10% of GDP for most years of the adjustment programme. As also indicated in Table 1, the

banking system's credit to the government as a proportion of total credit to the domestic economy has exceeded 40%, while the proportion of government's total credit financed by the Central Bank has increased from about 55% in 1985 to about 90% in 1991. Correspondingly, government's total domestic debt obligations have been growing at very high rates.

It should be observed that in most of the years since the adjustment programmes started in 1986, the annual budgets proposed by the federal government have often been in slight surplus or, at worst, in balance, perhaps in order to keep to the requirement of 'fiscal discipline'. But also, in most years, the ex post annual budgets have tended to be in huge deficits. This is often attributed to, among other things, the unanticipated increases in interest payments on the government's external debt and/ or shortfalls in oil revenues as a result of unanticipated falls in oil prices. According to the Central Bank of Nigeria's *Annual Report and Statement of Accounts* (1992, p.3):

> The larger deficit, in absoiute terms, was due mainly to large external debt service payments, as well as on the execution of the political programmes and economic development projects. Public debt outstanding increased substantially by 58.9 percent over the 1991 level.... Of the total amount expended, debt service payments constituted 61.1 percent, while expenditures on non-debt recurrent and capital expenditures absorbed 38.9 percent. Consequently, government fiscal operations resulted in an overall deficit of N44,158.5 million or 9.8 percent of GDP which was financed mainly by the Central Bank of Nigeria.

The huge budget deficits and the consequent rapid monetary expansion exerted pressures on the naira exchange rate, which depreciated persistently. Indeed, between January and March 1992, the naira depreciated by over 60% against major currencies. Domestic market interest rates have continued to rise since the adjustment programme due, in part, to the liberalization of the financial sector, and in spite of the excessive growth of money stock. It might seem paradoxical that interest rates should be rising instead of falling when budget deficits are financed by printing money, which generally increases the liquidity of the economy. In Nigeria however, the only handle that the monetary authority has in controlling the money supply is the credit to the private sector. Thus, given the helplessness of the monetary authority to control government's overdraft with the Central Bank, and in an attempt to stem the growth of the money supply, it tries to peg the maximum growth rate of credit to the private sector. As banks try to make profits from the limited lending activities permitted by the Central Bank, the spread between the deposit and lending rates continues to widen. The rising interest rates combined with the rapidly depreciating local currency and high inflation have tended to slow the growth of output, especially in the non-oil sectors.

Table 2: Exports by major commodity groups

products	Agricultural	Mineral products (oil)	Manufacture/ semi manufacture of products	Textiles	Chemicals	Other manufacture	Other Ex. exports
1986	4.6	93.8	0.6				1.0
1987	5.2	92.9	0.2				1.6
1988	9.1	88.4	0.3				2.2
1989	3.2	94.9	0.2	0.2	0.0	0.1	1.4
1990	2.1	97.0	0.1	0.1	0.1	0.4	0.2
1991	2.7	96.2	0.1	0.2	0.2	0.1	0.4

Source: Compiled from Central Bank of Nigeria's *Annual Report and Statement of Accounts* (various years)

One major achievement of the SAP regime was the elimination of import-licensing and the bold steps to reform the structure of tariffs. Almost all the price controls and import licensing requirements were abolished and the import prohibition list was shortened. The 30% import surcharge was abolished and the government also adopted an interim import duty and excise schedule that somewhat reduced the level of protection. The reform of the foreign exchange market and the consequent devaluation of the naira was expected to have beneficial effects on the external sector, especially on the exports of non-oil products. As Table 2 shows, the non-oil exports (agricultural products) as percentage of total exports increased steadily from 4.6% in 1986 to 9.1% in 1988, before declining to 2.0% in 1992.

Table 3: Exports by major trading partners (percentage of total exports)

	Common Wealth Countries	Eastern Europe	Japan	UK	USA	ECOWAS	Western Europe	Others
1985	5.99	0.28	0.06	4.60	18.06	3.31	61.58	6.12
1986	4.29	0.23	0.15	5.67	34.96	3.82	47.58	4.19
1987	2.89	0.03	0.08	1.79	46.99	5.53	40.07	2.63
1988	3.00	0.19	0.12	1.89	45.97	5.57	38.61	5.35
1989	0.85	0.10	0.22	1.75	53.32	5.52	34.36	3.88

Source: Central Bank of Nigeria's: *Statistical Bulletin, 1992.*

Oil exports continue to dominate the export products. Indeed, it is believed that the increase in the percentage of non-oil exports from 1986 to 1988 may be due to a slump in the oil market in those years rather than to any appreciable increase in non-oil exports. In terms of direction of Nigeria's exports, the structure has not changed. Table 3 indicates that the United States remained Nigeria's major trading partner. Since 1987, the USA has imported more from Nigeria than the Western European countries combined. The US imports from Nigeria consist almost entirely of oil.

The trend that started in the import structure in the early 1980s continued throughout the SAP period. This trend is reflected by the domination of the import items by the capital goods and raw materials. The consumer goods share of total imports declined over the period, but showed a sharp rise to 34% in 1992 (see Table 4). On the whole, the current account balance has been modestly positive especially since 1989. The negative balance of payments accounts is mainly due to the impact of debt service payments on the capital accounts.

Table 4: Imports by major groups (percentage of total imports)

	1985	1986	1987	1988	1989	1990	1991	1992
Consumer goods	22.1	21.8	24.1	28.7	27.3	26.7	24.8	33.8
Durable goods	7.8	3.6	4.7	1.0	4.0	3.20	4.20	3.2
Non-durable goods	14.3	18.2	19.4	27.7	23.3	23.5	20.60	30.6
Capital goods/								
Raw materials	76.3	78.1	75.9	71.3	72.6	73.6	74.8	65.6
Capital goods	34.9	36.2	42.4	32.0	44.7	40.5	38.0	31.7
Raw materials	41.4	41.9	33.5	39.2	27.9	32.8	36.8	33.9
Miscellaneous	1.6	0.1	0	0.0	0.10	0.0	0.4	0.6

Source: Central Bank of Nigeria, *Annual Report and Statement of Accounts* (various years).

From the brief review of the adjustment process so far, it is evident that there are therefore two main sources of shocks originating externally whose impacts on the Nigerian economy, and hence on the outcomes of the adjustment process, are substantial. One is the variation in the interest rates on the government's debt to foreign creditors. The other is the variation in oil prices, which is sometimes unanticipated. These two shocks have strong impacts on the government's budget behaviour. Tangential to the second shock is the terms of trade shock, especially since the early 1980s when the prices

of most of Nigeria's exports began to decline in the face of progressive increases in the prices of its imports. In an economy that is heavily import dependent, the balance of payments implications of the declining terms of trade are severe. More so, with this dependence of both the tradeable and non-tradeable goods sectors on imported inputs, the potential short-to medium-term costs of an adjustment process that relies substantially on expenditure switching and reducing policies may be great.

II. Theoretical model and estimation results

The last section showed that Nigeria's macroeconomic trends are not sustainable and reviewed some desired changes in policy regime. The benchmark model presented here is not designed to exactly capture past trends. Rather, the model combines some characteristics of the economy with policy rules that are consistent with proposals in the SAP package or that are consistent with policy rules that should be adopted. The benchmark model is largely counterfactual to historical experience and thus the model asks, 'what would happen if' Nigeria were to have a policy regime in place such as the one assumed in the benchmark model.

Clarification of methodological issues

Modelling a small, open developing economy such as Nigeria presents some analytical and methodological problems. The issues that confront the model-builders include the choice of an appropriate theoretical framework for modelling the economy; the extent of institutional and structural details to be incorporated in such a model; and what should be the 'correct' use of macro models in such economies.

The state of the economics profession indicates that there are several modes of economic reasoning, based on alternative visions of the economic system or specified analytical techniques. The different visions of the economic system, formulated into alternative theories of economic behaviour, constitute the different analytical frameworks for economic analysis. Thus, even when the major objective of a modelling activity is the systematic understanding of the structure and operations of an economic system, the diverse theoretical frameworks about the functioning of the economy significantly determine the specifications of the equation system and, implicitly, the purposes the model can serve. The choice of a theoretical framework is therefore critical to a model's construction and interpretation.

In many developing countries especially in Africa, economy-wide models as inputs into policy analysis are still at a rudimentary stage of development. Most of the models are developed as dissertations for doctorate degrees and are hardly maintained for policy analysis. In a majority of the cases, the analytical transparency of model design and results are not paramount considerations. The emphasis is often on building models that 'track history' and apply mainly to short-run policy analysis. One justification for this strategy is that these developing countries are characterized by rudimentary financial systems, dual economic systems, structural rigidities, and economic activities heavily

controlled by the government. Also, economic policy in these environments is perceived to be ad hoc in nature. Policy makers are not guided by any consistent framework, nor is intertemporal consistency in economic behaviour emphasized. In view of this, many scholars have questioned the relevance of any of the mainstream analytical frameworks in explaining economic behaviour in most developing countries. Modelling efforts have therefore largely proceeded by specifying equations that, given the assumed peculiar institutional characteristics of the economy, appear to give 'sensible' explanations of short-run economic behaviour. Long-run sustainability of short-run behaviour is not emphasized.

A large number of such macroeconomic models have been constructed for Africa. A survey of modelling efforts in Africa by Harris (1985) showed that there were about 184 macroeconomic models on various African economies, 33 of which were on Nigeria. Most of the models on Nigeria (see for example, Ojo, 1972; UNCTAD, 1973; Adamson, 1974; World Bank, 1974; Olofin, 1977; Uwujareen, 1977; NISER, 1983; Ekeoku, 1984; CEAR-MAC IV [see Olofin, 1985]; Poloamina, 1986; Soludo, 1989; etc.) are either the products of doctoral theses or represent one-shot research efforts to write journal articles, or the models are built to analyse specific issues and not maintained thereafter. Thus, with the exception of the CEAR model MAC-IV (developed and maintained by the staff of the Centre for Econometric and Allied Research, University of Ibadan), none of the models has been maintained for policy analysis[2].

Despite the large number, one sobering observation by Harris (1985:4) was that very few of the models in Africa shed any light on any of the issues that have been central to international discussions of IMF and World Bank proposals for stabilization and structural adjustment. He notes in particular that the consequences of exchange-rate adjustment, relaxation of quantitative controls over imports and credit allocation, raising domestic interest rates, controlling budget deficits, etc., are barely touched upon in any of the models that have actually been used by decision makers. Harris concludes by noting that one of the major challenges facing macroeconomists in Africa has to do with the development of appropriate theory that reflects understanding of how particular economies work and using this as a guide in the specification of models that are designed to shed light on the effects of alternative policy actions.

This is the crux of the matter and points out an important challenge for Nigerian macroeconomic modellers in particular. In Nigeria, for instance, macroeconomic modelling tradition is largely predicated on the old policy regime of excessive governmental controls and without a consistent analytical framework for either policy analysis on modelling exercises. Equation specifications have then been an exercise in the search for those that can give better explanatory power, rather than rooted in any framework of economic behaviour. The emphasis of the models is on 'tracking history', and the long-run sustainability of policy actions are largely ignored. Thus, the intertemporal budget constraints are not observed, and these models are not robust for analyzing the consequences of major policy shifts.

Since 1986, Nigeria has been implementing the IMF/World Bank supported structural adjustment programme. Various short-to long-term measures designed to deal with the country's severe balance of payments disequilibrium and macroeconomic instability have included standard stabilization policies (mainly expenditure-reducing in nature) and growth-inducing, supply-side reforms. These supply-side reforms involve significant liberalization of trade, capital inflows/outflows, financial markets and foreign exchange markets. Economic policy appears to follow a discernible pattern as dictated by the analytical framework for standard SAPs in developing countries (see for example, Research Department, IMF 1987; Corbo, et al (eds), 1987; Bacha and Edwards, 1988; etc). Domestic economic behaviour in response to changes in fiscal, monetary and exchange rate policies appears to be altering. Methodologically, therefore, this effort differs from earlier ones in the important sense that the modelling exercise is predicated on the SAP framework. The basic assumptions that underlie the modelling strategy are those that are consistent with the policy reforms under the SAP regime.

Our point of emphasis and departure from existing models is the need to root the modelling exercise in economic theory. The sustainability of a model across generations of users requires that it be understandable by the people who turn the crank and the ultimate users of the output of the model. This requires that the model be firmly grounded in economic theory so that the output of the model is intuitive to the user, or if some results are not initially intuitive because of general equilibrium outcomes that are not apparent in the partial models we all use in our heads, then it should at least be understandable (McKibbin, 1991:1). The basis for our predilection for the analytical transparency of the model design and interpretation is the current state of uncertainty about the functioning of a developing economy under a SAP regime. When uncertainty about a subject is pervasive, the profession should value analyses that can be readily and clearly understood (Bryant, 1992).

One may argue, and there may be ample reason to do so, that the received theories do not work well in the African context.

There is no agreement among modellers about the correct stance of theory in policy analysis and modelling: while some place greater emphasis on economic theory as the driving force, others emphasize the structural features of the economy. The view by some analysts is that economic theory is economy-specific, and thus the structural and institutional characteristics should be taken as a given, and economic theory and policy making designed to be consistent with the given features. It is therefore expected that a modelling exercise would aim to capture as much of the institutional and structural details as possible even if the analytical transparency of the results is suspect. Such models can indeed be important, depending on the purpose of the exercise in the first instance. For instance, an essential feature and emphasis of such models is to track history and explain reality as determined by the characteristics of the economy. In an environment of stable policy regimes and structures, the predictive ability of such models would be high. The robustness of the model becomes suspect if major regime shifts

occur (as under SAP) that also significantly alter the institutional and structural characteristics of the economy. In that instance, the past trends are less useful in understanding future prospects.

An alternative perspective assumes the universality of economic theory. It is argued that if the theories fail to work in some circumstances, it is because of certain distortions in the institutional and structural framework. In this case, both the institutional and structural characteristics are creations of economic policy and thus a theory-consistent policy framework can alter the given structures. For modelling purposes, therefore, this perspective places paramount importance on the analytical consistency of the model design.

In practice, however, economic modelling entertains the two assumptions. The difference is often on emphasis, and the choice of emphasis entails some trade-off. Unfortunately, the trade-off seems very steep: to obtain a highly disaggregated model capturing details of the institutional and structural characteristics, it appears to be necessary to sacrifice a great deal of analytical rigour; and to obtain a model whose results are clearly intuitively interpretable, some of what is apparently the reality is sacrificed.

Our preferred strategy for this research is to entertain as much of the institutional characteristics of the Nigerian economy as necessary while still ensuring that the resulting model is analytically intuitive. This is primarily because of the focus of the model as a policy model that can be used to analyse the implications of alternative policy scenarios of the what if kind: ultimately, the model can be revised to analyse other important policy issues, such as the concerns of the policymakers about stabilization with or without sterilization, nominal income or money targeting by the monetary authorities, exchange rate regime issues, alternative fiscal rules with respect to taxation, borrowing, debt servicing and spending, etc. We believe that these kinds of scenario analyses can be more meaningfully done with a model whose results are intuitive.

The model reported here is highly aggregative in nature. The issue of the extent of sectoral disaggregation to entertain in a model is an important methodological issue, but one that is largely informed by the purpose of the study. Our strategy in the current effort is to start with a relatively small model whose results can be understood and, later on, to systematically expand the model structures.

For example, there are several aspects of the model equations where we consider further disaggregation necessary. The production block, exports, investment expenditures, and prices are some of the variables that may deserve further disaggregation depending on the use to which the model would be put. Of course, there is no rigid procedure for any disaggregation exercise nor is there any limit to the conceivable kinds of disaggregation that can be entertained. For example, the production or supply sector could be disaggregated into say, agriculture, livestock, mining, manufacturing, utilities, building, construction, distribution, transport, communications, government, and other services. Many of the above can, in turn, be sub-divided into smaller sub-sectors.

Exports can also be disaggregated by major trading partners (that is, by direction of trade instead of commodity groups) but this is not pursued in the present model because one of our objectives is to examine the performance of non-oil exports when macroeconomic policies change. In a later version of the model when an effort would be made to refine the model's linkages to some global models, there may be some spin-offs in disaggregating exports by trading partners. However, given the explicit objectives of this study, we doubt that the qualitative results will be significantly improved by any further ambitious disaggregation scheme.

Two versions of the model are created: one assumes model-consistent, forward-looking expectations, and the other assumes that economic agents are backward-looking (adaptive) in their expectations . The model can also be simulated by switching between either a flexible or fixed exchange rate regimes. The version reported in this study assumes a flexible exchange rate regime. It is important to note here that the nature of transmission channels and links across model blocks is determined primarily by the assumed fiscal and monetary policy rules in place. This is one aspect of the modelling strategy that differs markedly from earlier practices in most models of African economies. Here, we make explicit assumptions about the type of fiscal and monetary policy rules, and the sustainability of such actions is also of prime importance, since the model is crucially concerned about the sustainability of adjustment paths. For example, one may expect that in a model of Nigeria, the links between the monetization of budget deficits, price inflation and real exchange rate should be evident. In essence, money supply may be expected to be endogenous, and the exchange rate pegged to the US dollar. This is one possible version of the model that can be created, but the links may be somewhat different principally because of the assumed fiscal rule. The discussion of alternative fiscal closure rules (see specification of the government sector) aptly summarizes the basic issues involved. During simulations, one can impose some of these fiscal rules and examine their implications on the behaviour model.

For example, one may assume that the current short-run behaviour of the government by the way of monetization of fiscal deficits is the fiscal rule in place (even though this will not be regarded as a fiscal closure rule in the sense that it does not ensure that intertemporal budget constraints are respected). This will require the elaboration of specification of money supply equation to capture the links between fiscal deficits and money supply, and since money plays a role in determining price inflation, the consequences of the monetization for the real exchange rate, interest rates, prices and the general behaviour model can be investigated. But the model will not have a sensible long-run solution because the fiscal rule in place is certainly not sustainable: the government cannot forever finance its deficits by monetizing it. Of the alternative closure rules that can be entertained for the model, the one we have adopted for the benchmark model assumes that the government issues new debt to meet its current deficits but constrains the Central Bank not to buy government debt. The government is assumed to target an exogenous path of debt to GNP ratio, and therefore adjusts the

tax rate to prevent the stock of government debt from rising forever relative to GNP. In this case, the transmission effects of government fiscal deficit will be substantially different.

Another potentially innovative feature of the model is the treatment of expectations. Most large-scale modelling exercises of African economies have usually imposed adaptive expectations. This may be partly attributed to difficulties in solving forward-looking, rational expectations models. However, it can be said that both of the currently used methods of modelling expectations formation adaptive and model consistent expectations are extreme characterizations and probably wrong. True behavioral relationships may well lie somewhere in between the extremes (Bryant, 1992). Economic agents in Nigeria, especially under the SAP regime, can be presumed to take their decisions on the basis of both hindsight and foresight. The model is solved imposing either the adaptive or the forward-looking expectations. Some modellers have attempted to capture the effects of expectations by incorporating some learning behaviours but such efforts are not without some serious criticisms. In the absence of an agreed procedure for building the half-way house between the two extremes, we propose to present and compare the results of the two expectations schemes.

Summary of the model structure

The model of Nigeria presented below is a medium-sized one. It is made up of 61 equations, out of which 19 are stochastic and 42 are definitional equations. There are about 23 exogenous variables and parameters in the model. It is presented in five major blocks, namely, domestic absorption, external trade, monetary sector, production and prices, and external debt.

The model combines elements of the Keynesian framework (to permit evaluation of short-term stabilization issues) and the neoclassical long-term growth properties (see Khan and Montiel, 1989). It incorporates some issues characteristic of Nigeria's debt profile and government policy responses to internal and external shocks, and also captures the economy's dependence on the volatile oil sector. It is a model of a small, open developing economy in which external and internal shocks determine macroeconomic outcomes. The basic assumptions that underlie the modelling strategy are those that are consistent with the policy reforms under the SAP regime, namely, open current account, liberalized financial and trade sectors, and flexible exchange rate.

While capital mobility is assumed, it is recognized that Nigeria is a heavily indebted developing country and there may be several factors that may make claims on it carry some degree of default risk. So the rate of return on Nigeria's liabilities will take account of the expected return instead of simply the contractual obligation. For example, external investors in Nigeria will demand a premium on new debt if outstanding obligations are selling at less than par. Thus there will be an arbitrage relationship that

sets the domestic interest rate equal to the world interest rate adjusted for default risk. The assumed arbitrage conditions are predicated upon an assumption of capital mobility.

Traded goods prices (oil, commodity and import prices), interest rates and exchange rate are the primary means through which external factors affect the domestic economy. Another important channel of linkage to the rest of the world is the external debt service payments. Debt service payments have impact primarily on the government fiscal deficit, and through the government's borrowing and endogenous tax behaviours affect the monetary and real sectors of the economy. Investment is derived from capital stock adjustment framework that follows a partial adjustment mechanism, while private consumption follows a liquidity-constrained and unconstrained inter-temporal utility maximization. Exports and imports are modelled in the conventional manner with relative prices and activity being the major determinants. Prices in the domestic economy follow a Philips curve relationship that allows for overlapping contracts. Therefore both prices and wages are sticky in the short-run- permitting us to specify short-run output determination in a Keynesian manner while capacity output is determined by a neoclassical production function. The debt sector is elaborately spelt out, and an attempt is made to capture the relationships between the external debt and government's budgetary behaviour.

As indicated earlier, the model is solved by imposing either the adaptive or model-consistent, rational expectations in both the goods and financial markets. Forward-looking expectations is an important innovative feature of the model results. For example, changes in policy today - or expected changes in policy tomorrow - will have an immediate effect on the jumping variables - the exchange rate, interest rate, and prices. The detailed specifications of the model equations are laid out below.

Figure 1. Flow chart showing major linkages in the model blocks.
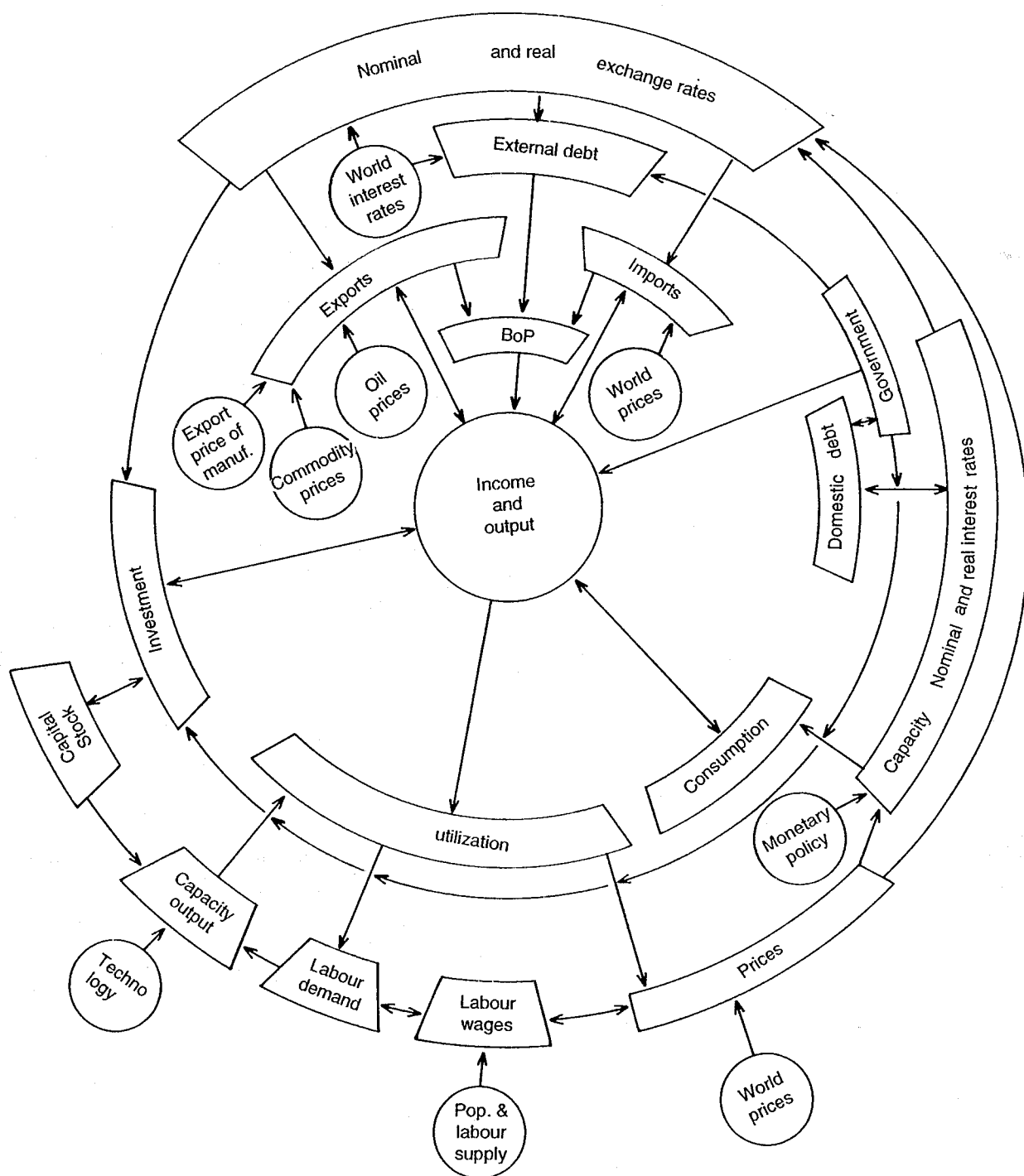
Block A model specifications: domestic absorption

Domestic absorption comprises private consumption expenditures (CP), private investment expenditures (INV) and exogenous government expenditures (G) on goods and services (that is, total expenditures, GEXP, less total debt service payments, TSERV).

Private consumption expenditures

A single private consumption equation is estimated without disaggregating the total expenditures into purchases of durables and non-durables. The specification is a fairly conventional one and follows closely the specifications by Blinder and Deaton (1985), Lahiri (1989), and Haque, et al (1991). The equation is given as follows:

$$\delta \ln CP_t = \alpha_0 + \alpha 1 \ln YD_t + \alpha 2 \ln CP_{t-1} + \alpha_3 \ln YD_{t-1} + \alpha \ln_4 RLENR \qquad (1.1)$$

where δ is first difference operator, YD is real current disposable income and RLENR is real lending interest rate (long-term rate). Real disposable income is defined as the nominal gross domestic product less total income tax receipts (net of transfers) (YTAX), plus government debt service payments to domestic residents (DSERV), plus interest receipts on dollar denominated foreign assets of the private sector (PFA), minus interest payments on total debt owed by the private sector to external private creditors (NFPCAP), and minus interest payments on claims of the domestic banking sector (PCR).

$$YD_t = (GDP*PGNP- YTAX + DSERV + (URS*PFA_{t-1})/ER - \\ (URS*NFPCAP_{t-1})/ER - (LR*PCR))/PGNP \qquad (1.2)$$

PGNP is the GNP deflator; URS is the US short-term interest rate used to calculate debt interest payments; and ER is the nominal exchange rate (naira per US dollar).

Alternatively, disposable income and consumer expenditure can be linked to the net change in consumer wealth by the private sector budget constraint given as:

$$YD_t = CP_t + INV_t + \{ (MT_t -MT_{t-1}) +(PFA_t-PFA_{t-1}) - \\ (NFPCAP_t-NFPCAP_{t-1}) -(PCR_t-PCR_{t-1}) +(DDEBT_t- DDEBT_{t-1}) \}/PGNP$$

where INV_t is private investment expenditures; MT_t is the target stock of money supply; and $DDEBT_t$ is government bonds (total domestic debt of the government). All other variables are as previously defined. The above specification implies that

disposable income is allocated to consumption, investment expenditures and net changes in financial assets.

Private investment expenditures

Investment function is derived from a capital stock adjustment framework. The specification follows closely from the specifications of investment functions by Ahmed and Chhibber (1989), and Chhibber and Shafik (1990).

Nigeria depends heavily on imported capital goods and raw materials for most of its investment expenditures. It is therefore expected that the persistent depreciation of the local currency since the introduction of the adjustment programmes will have impacts on the cost of imported inputs, the supply price of capital, real wages, interest rate, and hence on the short-run profitability of investment expenditures.

Desired private capital stock (KP^*) is hypothesised to be a function of expected demand (GDP^e), the rental cost of capital (domestic and world prices of capital) proxied by the real domestic long-term interest rate (RLENR), the real cost of imported inputs (approximated by the real exchange rate [REXR], and government capital stock (KG). In a developing country such as Nigeria, a significant proportion of the government's capital expenditures is invested in the provision of basic infrastructures (roads, telephones, electricity, water supply) and these increase the productivity and profitability of private investment. It is expected that the negative short-run effect of REXR on KP^* is due to the higher real cost of imported capital goods that are not easily substitutable at home and the higher real cost of intermediate goods required for production, reducing the incentive to invest. Both the rental cost of capital and the real exchange rate are expected to negatively affect investment expenditures.

Desired capital stock equation might thus be specified in linear form as:

$$KP^* = \alpha_0 + \alpha_1 GDP^e + \alpha_2 REXR_t + \alpha_3 RLENR_t + \alpha_4 KG \qquad (2.1)$$

The capital stock adjusts to its desired level with an adjustment lag β, which takes a value between 0 and 1.

$$KP_t - KP_{t-1} = \beta \{KP^* - KP_{t-1}\} \qquad (2.2)$$

The evolution of the capital stock is given by

$$KP_t - KP_{t-1} = INV_t - Dep^*(KP_{t-1}) \qquad (2.3)$$

where Dep denotes the rate of depreciation.

Substituting (2.1) and (2.3) into (2.2) gives the equation to be estimated for private investment expenditures as:

$$INV_t = \alpha_0.\beta + \alpha_1.\beta lnGDP^e + \alpha_2.\beta lnREXR_t + \alpha_3.\beta ln(RLENR_t) + \alpha_4.\beta lnKG_{t-1} + (Dep.-\beta)lnKP_{t-1} \tag{2.4}$$

An identity for the gross capital stock can be derived from equation (2.3) as follows;

$$KP_t = KP_{t-1} + INV_t - Dep*(KP_{t-1}) \tag{2.3a}$$

Government sector

In this section, only the activities of the federal government are modelled. Ideally, it would have been better to capture the activities of all levels of government (federal, state and local) and public enterprises, but comprehensive and up-to-date data on the activities of other tiers of government are not easily available. In any case, given Nigeria's fiscal structure, the federal government's fiscal activities capture, for all practical purposes, Nigeria's public finance. The state and local governments depend on the federal government's statutory allocation for over 80% of their revenues; all external public debts are liabilities of the federal government and about only the federal government sells debt instruments in the securities market to finance its deficits.

The revenue-expenditure relationships of the federal government are modelled. One objective is to capture the implications of the persistent depreciation of the naira (local currency) in the face of huge and rising external debt-service obligations on government's fiscal balance. Reducing the government's fiscal deficits (expenditure-reducing) and devaluation of domestic currency (expenditure-switching) are two major policy instruments of the SAP package in Nigeria. Real depreciation of the naira improves the current account, but it also increases the naira value of debt-servicing obligations and imports, thus widening the budget deficit and stimulating the government's recourse to domestic borrowing and inflationary finance.

Government revenue

It is assumed that all tax revenues in the economy accrue to the federal government, which in turn shares all the collected revenues between itself and the other two tiers of government (state and local governments). The major sources of revenue to the government can be grouped into oil sources (accounting for over 75% of total revenue) and non-oil sources. Oil sources include the petroleum profit tax, revenues from rent and

royalties of the oil companies and the earnings of the Nigerian National Petroleum Corporation (NNPC) from domestic consumption of petroleum products. The non-oil sources include company income tax (about 2% of total revenue), customs and excise duties (10%), personal income (labour) taxes which account for about 10%, and other revenues. All these federally collected revenues are paid into the federation account and shared among the federal, state and local governments. Equations for the major revenue sources are specified below.

The equation for petroleum profit tax is specified to depend on the nominal naira value of oil export receipts.

The equation is specified as follows:

$$(1) \quad OILTAX_t = \alpha_0 + \alpha_1(OILEXP*PGNP) \tag{3.1}$$

where OILTAX is total nominal oil tax revenue and OILEXP is oil exports in constant naira.

Other oil related revenues (OTHOIL) are mainly the domestic oil sales revenue for the Nigerian National Petroleum Corporation (NNPC), and the rents and royalties paid by the oil companies. These revenues are determined by the level of aggregate demand and the domestic price of oil:

$$OTHOIL_t = \alpha_0 + \alpha_1(GDP*PGNP)_t + \alpha_2 DPOIL_t \tag{3.2}$$

where DPOIL is the domestic price of oil (which is fixed by the government and thus taken as exogenously given.

Revenue from taxes on the corporations is specified as a function of nominal income. Non-agricultural income might seem preferable as a base on the grounds that non-corporate farming dominates agricultural production in Nigeria. It would however be a serious omission to ignore the relatively small but growing number of large commercial farms that are now involved in agricultural production, especially since the introduction of the structural adjustment programme in 1986. Revenue from corporation taxes is therefore specified as follows:

$$(2) \quad COMTAX = \alpha_0 + \alpha_1(GNP*PGNP) \tag{3.3}$$

where COMTAX is company or corporation income tax.

The revenues from customs duties are defined as:

(3) $CUSTAX = tarifM*IMP*PGNP + tarifX*(EXP- OILEXP)*PGNP$ \hfill (3.4)

where CUSTAX is customs and excise duties; tarifM is average tariff on imports; tarifX is average tariff on non-oil exports; IMP and EXP are real naira values of total imports and exports respectively; and OILEXP is total oil exports.

Following the work by Masson, et al (1990:11), nominal income tax revenue net of transfers (TRASF) can be defined as:

$$YTAX_t = TRATE*((GNP*PGNP)- Dep*(PGNP*KP_{t-1}) + DRS*DDEBT_{t-1}) - TRASF; \qquad (3.5)$$

where YTAX is total income taxes; TRATE is the average tax rate on personal income; Dep. is the depreciation rate on capital stock (KP), and DRS is short-term domestic interest rate. Total income tax receipts are therefore related to a tax rate and a tax base, which is approximated by net national product plus interest receipts on domestic government debt. It is assumed that income taxes also accrue to the federal government. This is also paid into the federation account and the total revenue in the account is shared among the tiers of government.

Total nominal revenues can then be defined as:

$GTAX_t = OILTAX + OTHOIL +COMTAX + CUSTAX + YTAX$ \hfill (3.6)

The federally retained revenue (GTAXF) is given as a percentage of total revenue, that is:

$$GTAXF = fed*(GTAX) \qquad (3.7)$$

where fed is the exogenously determined share of the federal government in the federation account.

A few observations can be made about the narrow and specialized revenue base discussed above. Since Nigeria is both a quantity and price taker with respect to her export of oil, changes in either of these have serious consequences on the government's budget balance. Also, liberalization of trade that results in the lowering of import and or export tariffs will affect the government's revenue. Diversification of the revenue base may be difficult to accomplish in the shortrun given both the structure of the productive sectors and the technical and administrative defects in tax assessment and

collection. It is not easy to assess and collect taxes from the agricultural and wholesale and retail trade sectors, which are the major employers of labour. Therefore, government's revenue-expenditure relationship is at the moment largely determined by developments in the oil sector. It should also be noted that the flow of financial aid to the government has been ignored in the discussion of revenue sources principally because of its insignificance as a revenue source.

Intertemporal fiscal closure rules

There are various ways in which sets of equations representing various relationships can be conditioned to have sensible mathematical solutions. As Harris (1985:15) observes, these conditions or closure rules are the most important features in determining model response to policy interventions.

During the simulations, alternative assumptions about the government's fiscal behaviour can be entertained. These assumptions (fiscal rules) are designed to respect the intertemporal budget constraint, otherwise the model will not have sensible long-run solutions. Because of the central role of fiscal policy in Nigeria's economic life, the nature of these alternative closure rules has important implications for the modelling and behaviour of the rest of the model, especially the monetary sector, and the nature of linkages among the relationships modelled. Fiscal discipline is one of the goals of the adjustment process but one that the government has had the most difficulty in attaining. It is therefore of interest to investigate the implications for the economy of imposing some specific fiscal rules on the government's behaviour.

Moreover, one of the two versions of the model incorporates model-consistent, forward-looking expectations. With the programme of financial liberalization in Nigeria, it may not be unreasonable to presume some forward-looking behaviour in the financial asset markets. Generally, concern about intertemporal budget constraints and thus about the sustainability of current behaviour in the medium-to long-run is an important feature of forward-looking, rational expectations models. The likely fiscal closure rules that can be entertained during simulations are discussed below.

The fiscal rule to be implemented in this study assumes that the government has the power to issue new debt that is held by the domestic private sector (commercial banks and non-bank private sector) and by external investors. This rule entertains another assumption that is contrary to actual historical experience but consistent with the proposals for fiscal discipline and the need to eliminate recourse to monetization of budget deficits. Under the rule, government debt cannot be bought by the Central Bank of Nigeria. However, the government is assumed to target an exogenous path of debt to GNP ratio, and therefore adjusts the tax rate on personal income to prevent the stock of government debt from rising forever relative to GNP. In other words, this rule forecasts the changes in taxes necessary to stabilize the debt-to-GNP ratio to a

predetermined level after a given time. A feedback rule can be specified for the tax rate that makes it respond to both the level and the change in government total debt (domestic and external debt) relative to an exogenous target level (TDEBTT*). Following the lead by Mason, et.al. (1990), the difference between the actual and target level is divided by nominal GNP, so that a given deviation in the debt stock relative to GNP will elicit an equivalent tax rate response. This is a simulation rule with imposed parameters and can be specified as:

$$\delta TRATE_t = DUM * \{ \alpha_1((TDEBT - TDEBTT^*)/(GNP*PGNP)) + \alpha_2((\delta TDEBT - \delta TDEBTT^*)_{t-1}/(GNP*PGNP)) \} \qquad (3.8)$$

where δ is the first difference operator; DUM is an imposed dummy variable used to adjust the tax rate reaction function; TDEBT is total debt stock (domestic and external); TDEBTT* is target debt stock; and α_1's represent the imposed parameters.

This closure rule has important implications for the government's fiscal behaviour and also for the behaviour of the model. Since the targeted debt-to-GNP ratio includes the external debt component, it implies that any exogenous shock that raises the debt service payments and therefore either raises total government expenditures in the present period or raises the amount of unpaid arrears will result in the adjustment of the tax rate immediately or in the future. This will be true if the targeted debt-to-GNP ratio is to be attained and then maintained. So far, the focus of this tax rate reaction function is the tax rate on personal income. This is maintained for the analytical benchmark model, but it is possible to specify the reaction function such that revenue sources other than the income tax are varied. For example, the government could raise the tariffs on external trade and/ or the domestic price of oil. Any of these will lead to increased revenues to the government, but may also undermine some other aspects of its adjustment process. The crucial point is that whatever rule is enforced should be such that the intertemporal budget constraint will be respected. The rule could also illuminate policy analysis by forecasting the amount of domestic resources that must be mobilized if a particular expenditure profile is to be sustainable.

The previous tax-rate assumption about the fiscal behaviour of the government is only one among many assumptions that can be entertained during the simulations. However, the nature of any particular fiscal closure rule also determines the nature of the assumptions that can be entertained in modelling the monetary sector, and thus the relationship between the monetary and fiscal policy. For example, an alternative fiscal rule that could be specified would constrain the government not to issue additional debt, but to adjust taxes so as to keep budget balance. Nigeria's total debt-to-GDP ratio is already very high and some analysts may argue that a sensible and sustainable fiscal behaviour would require the government not to issue new debts but should adjust its taxes so as to meet its expenditures (including debt service payments). A tax rate reaction

function which adjusts tax revenues to maintain budget balance can thus be specified. Any increase in government expenditure in excess of current revenues would then have to be met by collection of additional tax revenues. An important practical question, however, relates to the feasibility of increasing non-oil tax revenues in the short to medium term. This rule may raise the need for creative re-thinking of Nigeria's fiscal federalism (in terms of flexibility of shares of the federation account in the face of external debt service payments jurisdiction over certain revenue sources additional revenue sources, improved efficiency in taxing the under-taxed tax base, etc). Alternatively, the fiscal constraint may inject the needed discipline into the government expenditure profile.

Another fiscal rule similar to the one above may constrain the government not to issue new debts and not to raise taxes, but to meet all its current expenditures (including changes in debt service payments) from its current revenues. This rule is akin to the balanced budget requirement and some analysts argue that it is one of the more effective ways to enforce fiscal discipline. If the government were to meet all its debt service payments, then the component of government expenditures devoted to the purchase of goods and services would have to adjust endogenously to available tax revenues. In other words, the government is constrained not to have an independent fiscal policy. Given the already very large stock of government debt (and thus the high debt service payments), this rule would mean that in the face of declining revenues or an exogenous shock that increases debt service payments, most of the total expenditure outlays would have to be devoted to debt service payments. The implications of this fiscal rule for the behaviour of the model will be interesting to examine.

Still another fiscal rule could mimic the current behaviour of the government, which may not be sustainable in the long-run. Under this assumption, the government issues new debt to cover any shortfall of revenue relative to outlays. This may be caused by, among other things, an increase in the external debt service payments or a fall in revenues. Most of the debt instruments are sold in the domestic market and are bought by the Central Bank, commercial banks and the non-bank private sector. Experience has shown that sometimes a major part of the debt instruments is held by the Central Bank of Nigeria. Domestic component of the government's total debts has therefore been rising explosively. In this regime, the government does not have an independent monetary policy, and an endogenously determined monetary policy will be modelled. However, this assumption cannot be regarded as a stable fiscal closure rule, because it does not ensure that the government respect the intertemporal budget constraint. A version of the model incorporating this behaviour may be created to study the implications of this apparently unsustainable budget behaviour on the behaviour of the model.

Government expenditure

The non-discretionary part of government expenditures (essentially the debt service payments) is modelled, and the rest is taken to be an exogenously determined policy variable.

In spite of the various efforts (at least during the budget preparation) to ensure balanced budget or even provide for moderate surplus, exploding budget deficits, ex post, have been a recurrent phenomenon especially since the adjustment programme. Given the emphasis of the adjustment programme on fiscal discipline, this phenomenon would appear to be paradoxical and is typical of the experiences of some other developing countries (especially in Latin America) undergoing the adjustment process. Efforts have been made to privatize and commercialize several of federal government's parastatals and also to review or remove some government subsidies. But it has been difficult for the government to contain the deficits. Depreciation of the local currency ensures that government realises increased naira revenues from oil exports. At the same time, the persistent depreciation of the naira and rising domestic inflation also lower the real value of government expenditures and thus necessitate an increase in the naira content of budgeted government expenditures so as to maintain the same or even lower level of real spending.

Beside the impacts of currency depreciation and political considerations that constrain the government from drastically cutting expenditures in several sectors (such as defense), there is one other principal factor that reinforces the deficits. This factor is the increases in domestic and external debt service payments. Over the period 1988 - 1990, debt service payments as a percentage of total expenditures were 40.7, 49, and 67 respectively. In 1990 for instance, total debt service payments increased by 104% over the 1989 level, and government expenditures as percentage of GDP correspondingly increased, from about 21% in 1989 to 26% in 1990. Also in 1990, the stock of domestic debt increased by 47.4%, while that of external debt (in naira) rose by 24%. The increase in external debt was attributed to "draw down of external loans, capitalized unpaid interest charges on rescheduled debt obligations, depreciation of the US dollar against other currencies and depreciation of the naira exchange rate" (see Central Bank of Nigeria, 1990:60). As the bulk of Nigeria's huge external debt is owed to private creditors at commercial rates, it is expected that variations in the world interest rate would affect the debt interest payments. Given the rate of growth of debt stock and the size of debt service payments as percentage of total expenditures, it is logical to expect that without drastic reductions in the other expenditures, budget deficits will be difficult to eliminate in the medium term.

As indicated earlier, the deficits are financed through borrowing. Since the existing debt-burden is high, it may be expected that potential bond buyers would attach a high default risk to government bonds and thus be reluctant to buy them. If, in addition, it

is assumed that capital mobility is not perfect (which is not the assumption entertained in the benchmark model), then the low domestic demand for bonds will drive real interest rates above world levels. The ratio of domestic debt to GDP rises. If a bulk of the government's debt instruments are purchased by the Central Bank of Nigeria, however, then money creation plays an important part in the government's efforts to make the internal resource transfer required to service its debt obligations, with enormous consequences on the economy's broad macroeconomic balance. Our benchmark model assumes that the new debt issues are not held by the Central Bank but by the domestic private sector and external investors. The specifications that follow are based on this assumption, but alternative versions of the model consistent with the various closure rules discussed earlier can be created during policy simulations.

Government's total nominal expenditures (GEXP) are divided into two: the exogenous expenditure on goods and services (G), and debt service payments (TSERV). The total debt service payments are then divided into the payments to service domestic debt (DSERV) and the actual payments made to service external debt (VOLSEV)[3]. These service payments represent an important linkage between changes in government's debt service obligations and the budget balance. In 1990 for instance, these payments constituted about 67% of total government expenditure, and correspondingly, domestic debt rose by 47%, external debt by 24%, and M1 increased by 45%.

The major identities are as follows: Total nominal government expenditures (GEXP) are given as the exogenous expenditures plus total debt service payments;

$$GEXP_t = (PGNP*G_t + TSERV \qquad (3.9)$$

The total debt service payments are given as:

$$TSERV_t = (DSERV_t + VOLSEV_t) \qquad (3.10)$$

and the government's nominal current budget deficit (GDEF) is given as the total nominal expenditures minus the total retained revenue of the federal government.

$$GDEF_t = GEXP_t - GTAXF_t \qquad (3.11)$$

It is assumed that the government fully services the stock of outstanding domestic debt. Each period, a proportion of the domestic debt is due for repayment, and the government retires this amount and also pays interest on the outstanding obligations. For the purposes of this study, we ignore for the moment the gross amortization and gross new issues, and focus on net change in the stock of debt. Domestic debt service payments are therefore specified as follows:

$$DSERV_t = DRS*(DDEBT_{t-1}) \qquad (3.12)$$

where DDEBT is the stock of domestic debt and DRS is the domestic short-term interest rate.

New issues of domestic debt add to the stock. The government is assumed to fully service its domestic debt, and changes in the stock of domestic debt equal the new issues of domestic debt:

$$DDEBT_t = DDEBT_{t-1} + Dom* GDEF_t \qquad (3.13)$$

where Dom is the proportion of government current deficits financed by borrowing in the domestic market, and is taken to be exogenously determined.

The above specifications of the government revenue-expenditure relationships imply that changes in external factors (oil price, OPEC oil production quota for Nigeria, external and domestic debt service obligations) have serious implications for the government's budget behaviour.

Block B model specifications: External sector

Exports

Exports are disaggregated into three goods: oil, primary commodities (mainly agricultural commodities) and manufactures. Oil exports account for over 90% of Nigeria's total export receipts. Total oil export at given international price of oil is determined by OPEC production quotas. At a later stage of the research when the model would be simulated interactively with some global models, the dynamic path of oil price can be derived from the global models. For example, in the IMF's global model, the MULTIMOD, the nominal price of oil is determined by the interaction of world aggregate supply and demand. Each region's oil consumption is a function of the region's real GDP and the price of oil relative to that of aggregate output. Imports of oil by the region (except the high-income oil exporting countries) are the residual between net domestic supply and consumption. The net oil exports of oil exporting countries then equal the sum of the excess demands of the industrial countries and non-oil exporting developing countries.

The volume of Nigeria's total oil export receipts (in constant units of local currency) for each year can be defined as follows:

$$OILEXP_t = ((PQOTA_t*POIL_t)/ER_t)/PGNP \qquad (4.1)$$

where OILEXP is total real oil exports; PQOTA is the proportion of OPEC production quota for Nigeria that is exported; POIL is export price of oil in US dollars; and ER is nominal official exchange rate.

Manufactures export is not as yet a significant proportion of Nigeria's total exports (less than 2%), but this classification is maintained to account for the export of manufactures and semi-manufactures of agricultural products, textiles, and every other export item not classified as oil or primary commodities. As a group, these export items constitute a very insignificant proportion of world manufactures exports. Their exports are assumed to be constrained by domestic supply conditions. Changes in exports might be specified to be constrained by changes in the total output of the non-oil sectors of the economy as the scale variable. Real exchange rate (REXR) is included to capture the effects of relative prices, and especially the impact of currency depreciation, which also affects the competitiveness of this class of exports in the world market. The average price of developing region's manufactures exports (PXM) in MULTIMOD is also used as a proxy for the prices facing Nigerian manufactures exporters. We have not adjusted the export price for export taxes because export duties are generally negligible in Nigeria. For example, there is no export duty on oil exports, while duties on non-oil exports have been very insignificant and indeed have been abolished since the adjustment process began in 1986. Since the specification is an export supply equation, the price variables - REXR and PXM - are expected to have positive coefficients. The equation for export of manufactures is therefore given as:

$$\delta \ln MAEXP_t = a_0 + a_1 \delta \ln(\Theta GDP_t) + a_2 \ln REXR_t + a_3 \ln(PXM_t/ER)_t \qquad (4.2)$$

where δ is first difference operator, Θ is the share of non-oil sectors in the GDP and MAEXP is the real manufactures exports.

Export of primary commodities (agricultural) (PMEXP) mainly follows the pattern of the specification for the manufactures exports. However, instead of the export price of manufactured exports, the naira value of the exogenously determined world price of commodities (PCOM*ER) is included as the relevant price variable. Exporters of primary commodities in Nigeria are assumed to be price-takers in the international commodity market. Nigeria is a negligible supplier to the world commodity market and an export supply equation for primary commodities is specified. Exporters are assumed to be influenced by the relative prices in their supply decisions. The equation for real export of primary commodities is given below with all the variables expected to have positively signed coefficients:

$$\delta \ln PMEXP_t = a_0 + a_1 \delta \ln(\Theta GDP_t) + a_2 \ln REXR_t + a_3 \ln(PCOM/ER)_t \qquad (4.3)$$

Total real exports (EXP) is therefore given as;

$$EXP_t = (OILEXP_t + MAEXP_t + PMEXP_t) \qquad (4.4)$$

An aggregate exports price can also be derived given that:

Oil export price = POIL/ER
Primary commodity export price = PCOM/ER
while the price of manufactures exports = PXM/ER;
then total exports price is given as:

$$DPXT_t = (OILEXP*POIL/ER + PMEXP*PCOM/ER + MAEXP*PXM/ER)/EXP \qquad (4.5)$$

Imports

Imports in Nigeria can be divided into two major activity groups: consumer goods, and capital goods and raw materials. Estimating separate equations for raw materials and capital goods reflects the fact that local manufacturing firms depend heavily on imported capital goods, and that the utilization rate of domestic industrial capacities depends on the adequacy of imported raw materials. Import of raw materials and capital goods (CAIMP) is assumed to be related to the production level and the capacity utilization rate in the manufacturing sector. Import of consumer goods (CNIMP) is a function of real disposable income as the relevant activity variable. In the two import functions, a measure of the real cost of imports (REXR), that is the real exchange rate, and real lending rate (RLENR) are included. Lagged dependent variables are also included to capture partial stock adjustment behaviour. Real exchange rate is defined later as the ratio of import prices (in local currency, DPIT) to domestic prices. The import equations are thus specified as follows:

$$\delta lnCAIMP_t = a_0 + a_1\delta lnGDP_t + a_2lnREXR_t + a_3lnRLENR_t + \alpha_4lnCAIMP_{t-1} + \alpha_5lnCAPUTL_t \qquad (4.6)$$

$$\delta lnCNIMP_t = \alpha_0 + \alpha_1\delta lnYD_t + a_2lnREXR_t + a_3lnRLENR_t + \alpha_4lnCNIMP_{t-1} \qquad (4.7)$$

Total imports (IMP) can then be defined as

$$IMP = CAIMP + CNIMP \qquad (4.8)$$

The price of imports in naira is derived as follows:

$$DPIT_t = ((IMP*DPIM)/ER)/IMP \qquad (4.9)$$

Trade balance (in local currency) can thus be defined as the difference between total exports and total imports:

$$TBAL_t = (DPXT*EXP - DPIT*IMP) \qquad (4.10)$$

Block C model specifications: Monetary sector

In this sector, the equations specified include those determining the demand and, or supply of money stock, interest rates (short and long term rates) and the exchange rates. Alternative assumptions about the government's intertemporal budget constraints may be crucial in determining which of the monetary variables can be exogenized or endogenized. For example, if it is assumed that the government faces an exogenous budget constraint and so cannot issue new debts but must meet all its expenditure and debt service payments either from current revenues or through changes in taxes, or that the new debt issues are not bought by the central bank, then it may be realistic to experiment with versions of the model alternatively endogenizing or exogenizing money supply. Under the assumption that the government debt instruments are held by the Central Bank (and this represents the current practice in Nigeria), then money supply can be treated as endogenous. The equations specified below are those that are relevant for the benchmark model. Appropriate modifications in the equations consistent with the various fiscal closure rules can be made during policy simulations.

Equations specified are those of money demand, a central bank's reaction function determining short-term nominal interest rate, long-term nominal interest rate, real short- and long-term rates and exchange rates (nominal and real). Disequilibrium effects in the money market affect primarily the interest rate and prices, and through these channels affect employment and output, financial flows, etc. The major channel through which monetary policy instruments affect the domestic economy is the cost-of-capital effect. Monetary policy is assumed to affect directly the short-term interest rate and indirectly through a term-structure-of-interest rate relationship to affect the long-term rate. The interest rate variable appears in the investment equation, thus permitting the IS-LM type linkage between the financial and real sectors.

Demand for real money balances is specified to be a function of real income (GNP), nominal short-term interest rate and the current and expected inflation rates. It is conventional to specify money demand function to depend on income and nominal interest rate, where the nominal interest rate measures the opportunity cost of holding money.

Inflationary expectation is also specified as an alternative measure of the opportunity cost of holding money in developing countries. It is argued that because of the underdeveloped financial markets in developing countries and the high inflationary levels, agents try to hedge against inflation by investing in physical assets rather than holding money. The inflationary term is therefore expected to be negatively related to the demand for money. Our specification below includes both the nominal interest rate and inflation terms in the demand for money function. However, estimation results indicate that the interest rate variable is a more appropriate measure of cost of holding money in Nigeria. A lagged dependent variable is also included to capture the partial stock adjustment process in the demand for money function. The equation is given as:

$$\ln(M/PGNP)_t = \alpha_0 + \alpha 1 \ln GNP_t + \alpha_2 DRS_t + \alpha 3 \ln(M/PGNP)_{t-1} + \alpha_4 \ln INF_t + \alpha_5 \ln INF^e \tag{5.1}$$

> *where* M is the desired money stock, DRS is nominal short-term interest rate, INF is the inflation rate, and INF^e is the expected inflation rate.

Interest rate

Equations for the nominal and real short and long interest rates are specified. The equation for the short-term nominal interest rate is specified as the central bank's reaction function. It is assumed that the central bank adjusts the short-term rate to close the gap between a target for money stock and its actual value. Government's borrowing activities in the domestic financial market are expected to raise domestic interest rates. This reaction function does not necessarily capture the actual historical experience. In the past, though the central bank has varied short-term and inter-bank lending interest rates to elicit certain reactions from the financial system, it relied mainly on direct controls of credit for its monetary policy. The rationale for the specification in our benchmark model stems from the policy directions under the ongoing liberalization of the financial system and the switch from direct to indirect instruments of monetary policy. It is expected that the central bank will increasingly rely on the manipulation of interest rates to control money supply. As a variant of similar specification in Masson, et al (1990), the function is given as:

$$\Delta DRS = \alpha_1(DRS_{t+1}-DRS_{t-1}) + \alpha_2 \ln(MT/M)/(m3) + \alpha_3(DDEBT_t-DDEBT_{t-1}) \tag{5.2}$$

> *where* MT is the target money stock, and m3 is the coefficient of the DRS term in the demand for money function.

The real short-term interest rate (RSR) is defined as the nominal rate adjusted for growth in the price level in the current period:

$$RSR_t = (DRS_t/100)/(PGNP_{t+1}/PGNP)-1 \qquad (5.3)$$

Under the consistent expectations, the long-term interest rate (LR) is related to the short-term rate by a term-structure relationship. In the version with adaptive expectations, the long-term rate adjusts gradually to observed innovations in the short-term rate[4]. The equations are given as follows:

$$\text{Consistent expectation: } LR_t = \Sigma^7_0 \ (DRS_{t+i})/8; \qquad (5.4)$$

$$\text{Adaptive expectation: } LR_t = \alpha_1 DRS_t + \alpha_2 LR_{t-1} ; \qquad (5.4a)$$

where α_i are imposed parameters and are homogenous of degree one.

The real long-term rates (RLENR) (under consistent and adaptive expectations) are similar to equations (5.4) and (5.4a) above but the nominal short-term rate is replaced by the real short-term rate (RSR):

$$\text{Consistent expectation: } RLENR_t = \Sigma^7_0 \ (RSR_{t+i})/8 \qquad (5.5)$$

$$\text{Adaptive expectation: } RLENR_t = LR/100 - INFEA \qquad (5.5a)$$

where INFEA is inflationary expectations when expectations are adaptive

Exchange Rate

The strategy for modelling an exchange rate depends crucially on the assumptions made about the maturity of the financial system and nature of capital mobility in Nigeria. If capital assets are assumed to be perfectly mobile, and hence the domestic financial assets are perfect substitutes for international assets, then the naira exchange rate (defined as the amount of foreign currency [US$] per unit of local currency) can be determined by an interest parity condition that adjusts the naira value to, say, the US dollar.

In Nigeria, however, the process of financial liberalization has led to an evolution in interest and exchange rates determination from a system of statutorily determined rates to gradual de-control of the system. Currently, the rates are allowed to be market determined. Also, it is assumed that capital is mobile. This may not be an unreasonable assumption. In the recent past, capital controls have lessened and agents now allocate some of their portfolios between domestic and foreign financial assets. For example, it

is not uncommon to find that individuals and firms in Nigeria hold their bank deposits in both the local currency (naira) and US dollars. Deposits in dollars earn interest based on the rate prevailing in the United States.

Exchange rate behaviour is therefore hypothesized to follow an interest parity condition. The current value of the exchange rate adjusts relative to its expected future value and default risk premium on Nigeria's external debt to equalize the domestic and US short-term interest rates.

$$ER_t = \{ (1+DRS/100)/((1+URS/100)*(1+DRP)) \}*ER^e \qquad (5.6)$$

where ER is current nominal exchange rate; URS is the United States' nominal short-term interest rate; DRP is default risk premium; and ER^e is the expected exchange rate.

As an alternative to the above uncovered interest parity equation, the naira could be assumed to be fixed to, say, the US dollars. The fixed rate could be with finite bands - the so-called 'exchange rate target zones' and perhaps of the type practiced within the exchange rate mechanism of the European Monetary System. In this circumstance, it could be assumed that the central parity for the US dollar/naira exchange rate is set exogenously by the Central Bank of Nigeria, but with occasional discrete changes in the parity. For such an assumption, a different path for the central bank's reaction function must be specified. For example, instead of the assumption that the monetary authority moves the short-term interest rate to narrow the discrepancy between a target for the stock of money and its actual value, we might assume that central bank adjusts the short-term rate to maintain a given dollar/naira parity. The change in short-term interest rate could be specified to be a nonlinear function of the gap between the exchange rate versus the dollar and an exogenous target level[5]. The money supply would then be completely endogenous.

Under the forward-looking expectations, agents are assumed to forecast the future exchange rate accurately and thus, the expected exchange rate (ER^e) can be defined as the next period exchange rate, that is:

Consistent expectations: $ER^e = ER_{t+1}$ \qquad (5.7)

Adaptive expectations: $EREA = EREA_{t-1} + \alpha_1(ER- EREA_{t-1})$

The real exchange rate (REXR), defined as the ratio of tradeable and non-tradeable goods prices, is here given as the ratio of export prices (in local currency) to the domestic price level (PGNP):

$$REXR_t = DPXT/PGNP \qquad (5.8)$$

Block D model specifications: Production and prices

Production

In this section, aggregate output (GDP) and income (GNP) variables are defined. The equation determining capacity output is also specified. It is assumed that in the short-run, output is determined in a Keynesian manner by the components of aggregate demand, but the long-run capacity output is determined by a neoclassical production function.

This specification may imply that the observed capacity under-utilization in the economy results from lack of demand. Some scholars would argue however, that because of foreign exchange constraints and other factors, short-run output in some developing countries is supply-constrained. It is our view that the emphasis of either the demand or the supply side is an empirical issue. The two may perhaps be extreme characterisations of the underlying process and the choice of one to the neglect of the other may not accurately describe the entire reality. For example, the emphasis of the supply side would analytically imply that a version of Say's law prevails in the economy and therefore prices are flexible enough to clear the markets. In Nigeria, for instance, this assumption would neglect the often reported large inventory of unsold goods by firms, or the sluggish adjustment of labour wage rate to observed innovations in price inflation. Besides, it may be difficult to argue a case for foreign exchange constraints in a regime of flexible exchange rate, as approximated by the current exchange rate determination process in Nigeria.

Furthermore, recent studies of the economic performance in Nigeria under the adjustment programme provide evidence that weak consumer demand and rising stocks have been constraining the manufacturing sector from meeting expected growth rates. For example, Nigeria's First National Rolling Plan 1990-1992 (page 84) observes that some of the factors that inhibit domestic output are prohibitive cost of replacing equipments, increase in the cost of raw materials and high interest rates. The later, in turn, led to high cost of production of finished goods. This, accompanied by consumer resistance, led to reduced demand.

This finding for Nigeria may not be inconsistent with what can reasonably be expected under a SAP regime. Observed under-utilization may be symptomatic of the radical departure under SAP, from the previously expected path of economic policies. With the existing capacity, the new policy reforms render some past investment decisions unprofitable due to valuations in relative prices. Relative to the level of aggregate demand, unprofitable firms may be forced into obsolescence or operate at less than full capacity due mainly to their cost ineffectiveness. This is the phenomenon reported for the former communist East European countries and may also characterize the transitional phase for many structurally adjusting developing countries.

However, whereas we recognize the relative merits of the arguments for emphasizing one side or the other, especially the need to emphasize the supply side for some developing countries, care should also be taken of some subtle issues that might undermine the analytical interpretation of the results.

In any case, it doesn't seem as if the dichotomy between the supply-siders and the Keynesians matters greatly. In a recent study, Friedman, (1991: 1) has shown that,

> The distinction between aggregate demand and aggregate supply as the principal location of the disturbances that drive business cycles - the distinction most popularly associated with real business cycle models -is less important from a policy perspective than is commonly believed. The policy prescriptions that follow from these models have more to do with the kinds of assumptions that they incorporate about how the markets function than with whether the chief economic disturbances work through demand or supply.

Our strategy is to model this sector in a manner consistent with the overall model framework, to permit investigation of short-run stabilization issues as well as long-run growth (structural adjustment) issues. While short-run output is determined in a Keynesian manner, care is taken to model one component of aggregate demand, i.e investment,to capture some short-run supply constraints, such as the price of imported inputs. Furthermore, the model ensures that long-run factors (supply factors) determine capacity (or potential) output, which in turn is used to derive a measure of capacity utilization or demand pressure (expressed as a ratio of actual to capacity output) in the wage and price equations, thus ensuring a dynamic interaction between short-and long-run factors in output determination. The equations are laid out below:

Real GDP is defined as:

$$GDP_t = CP_t + INV_t + G_t + (EXP_t - IMP_t) \qquad (6.1)$$

and the real Gross National Product (GNP) is defined as:

$$GNP_t = GDP_t + (AUR*NFA_{t-1})/PGNP \qquad (6.2)$$

where AUR is average US interest rates on the two sources of external debt (that is, URS and FUR) and NFA is net foreign assets in local currency.

Aggregate supply equation determining capacity output is assumed to be determined by a Cobb-Douglas production function of the simple form:

$$YCAP = f(KP, KG, LF, T) \qquad (6.3)$$

where YCAP is capacity output; KP is gross private capital stock; KG is public capital stock; LF is labour force; and T is a time trend that captures the effects of technical change. Real potential output is thus specified as:

$$lnYCAP_t = \alpha_0 + \alpha_1 lnKP_{t-1} + \alpha_2 KG_{t-1} + \alpha_3 lnLF_t + \alpha_3 T \qquad (6.4)$$

where all variables are as previously defined.

Employment

Employment in the model is assumed to be demand determined. This is not unreasonable in view of the high level of unemployment in the economy. In modelling this section, we abstract from the dualistic nature of the labour market (that is, an under-utilized labour in the rural sector and an urban wage differential). It should be noted, however, that the share of agriculture in the GDP and the share of the labour force engaged in it have declined steadily since the 1960s. The rural-urban wage differential is reported to have narrowed significantly since the adjustment programme. Besides, the supply sector is modelled in a highly aggregative form but in a future extension of the model with greater sectoral disaggregation, it may be necessary to experiment with different labour market behaviours. Market forces have been playing an important role in wage and employment determination. We have therefore assumed a homogenous labour market.

Changes in labour supply are assumed to be exogenously given and to grow at a constant rate. Change in labour supply in the base year is measured by the number of graduates from the educational system (primary through university levels). Equations for labour demand and the wage rate are specified below.

Change in demand for labour is specified simply as a function of real wage and capacity utilization rate. Capacity utilization rate (CAPUTL) is defined as the ratio of real GDP to real potential GDP (YCAP). The equation is given as:

$$\delta lnLF_t = \alpha_0 + \alpha_1 \delta lnWG_t + \alpha_2 \delta ln(CAPUTL)_t \qquad (6.5)$$

where LF is the labour force employed, and WG is the real wage rate.

$$CAPUTL_t = GDP/YCAP \tag{6.6}$$

Wage determination follows the conventional Philips curve specification, with the rate of unemployment (UE) and the rate of inflation as explanatory variables. Perfect indexation of wage contracts to the rate of inflation is not the practice in Nigeria. However, it is expected that wage negotiations take account of inflationary pressures. Following the work of Chadha, Masson and Meredith (1991), the wage rate equation is specified to capture a regime of overlapping wage contracts in which backward-looking and forward-looking elements determine current wage rate. Past and expected inflation rates are therefore included in the wage rate determination. The effect of labour market disequilibrium is captured by the current unemployment rate (UE). The wage rate equation is thus given as:

$$WG_t = +\alpha_1 INF_{t-1} + \alpha_2 INF^e + \alpha_3 UE_t + \alpha4WGt\text{-}1 \tag{6.6}$$

The excess demand term (UE) further serves to capture the neoclassical market adjustment mechanism. During the simulations, it may be necessary to set the inflationary feedback into wage adjustment so as to preserve price neutrality in the model over the long run. For example, the coefficients of the lagged and expected inflation terms may be constrained to sum to unity so that a purely nominal shock in the model (a doubling of money suppy for example) would not have real effect on the domestic economy in the long run.

$$UE_t = LF\text{-}LF^s \tag{6.7}$$

where LF^s is the exogenously determined labour supply.

Prices

In this section, equations determining the domestic price level (in this case the GNP deflator) and the growth rate of the deflator (price inflation, INF) are specified. Further extensions of the model in the future will differentiate between output and consumer prices and incorporate other prices such as the consumer price index and sectoral output prices. The current study is highly aggregative.

The domestic price level (PGNP) is defined as:

$$PGNP_t = (PGNP_{t-1})*(1 + INF_t) \tag{6.8}$$

where INF (inflation rate) is the rate of change in PGNP.

Movements in prices are assumed to be determined as a mark-up over unit costs in the long run. Cost elements would include smoothed changes in labour costs, capital costs and import costs. Labour costs are measured by the wage rate (WG) while the cost of imports is measured by the import prices in local currency (DPIT). Profit margins are assumed to depend positively on the rate of capacity utilization (CAPUTL). A lagged inflation rate is included to capture the partial stock adjustment, and also measures inflationary stickiness. The inflation equation to be estimated (with all variables in logs) is thus given as:

$$INF_t = \alpha_0 + \alpha_1 \delta WG_t + \alpha_2 INF_{t-1} + \alpha_3 (\delta DPIT_t) + \alpha_4 \delta (CAPUTL)_t \qquad (6.9)$$

where INF is inflation rate.

Block E model specificaions: Measuring the effect of debt overhang

There has been growing attempt to capture the relationship between a country's external debt and its domestic economic conditions. The linkage mechanisms between the two would depend mostly on the nature of intertemporal budget constraint imposed on the government budget behaviour. As discussed earlier, it is assumed that the government issues new debts to meet any shortfall between revenues and outlays but must raise taxes so as to respect the intertemporal budget constraint. Linkages between external debt and domestic economic conditions are modelled to operate primarily through the government budgetary behaviour.

A potential source of changes in debt interest payments is the change in the world interest rates induced mainly by monetary and fiscal policies in the industrial countries. If there are no changes in the government's oil revenues, then any such variations in debt obligations, say an increase, would result in one of the following actions by the government. First, it could lead to a shift of resources away from the component of its revenues earmarked for purchases of domestic goods and services into the proportion devoted for debt servicing. Since government spending is a prime mover of domestic economic activities, this option would be growth-reducing. Alternatively, the increases in debt service obligations could be translated into increased budget deficits, financed by borrowing from both the domestic and external sources. This would have implications for domestic money supply, interest rate, prices, exchange rate, rising stock of debt, and private investment. It would also affect the confidence of the external creditors on the prospects of economic recovery. A third scenario would be for the government to

reschedule or capitalize the increases in external interest payments, thereby increasing the stock of external debt. This would affect the creditors' perceptions of the country's creditworthiness, which might lead to capital flight and thus affect investment, exchange rate, money supply and others. It should be noted that another external shock, say a decrease in either or both the oil price and Nigeria's OPEC production quota, could confront the economy with a similar dilemma. The structure of the debt sector outlined below tries to capture these essential linkages.

Total debt shock

Equation 7.1 below defines the total stock of external debt outstanding, measured in local currency (EDEBT), as the sum of debt owed to private creditors (PDEBT) at commercial interest rate, plus the stock of debt owed to official agencies (ODEBT) (such as foreign governments and multilateral agencies like the World Bank, IMF, etc.) at fixed, concessionary interest rates. Interest rates on private debt float with movements in a key market rate, for example, the London Interbank offer rate (LIBOR) or the US prime rate. Total external debt is given as:

$$EDEBT_t = (PDEBT_t + ODEBT_t)_t \qquad (7.1)$$

Government's total debt stock, TDEBT, (domestic and external) is thus defined as:

$$TDEBT = EDEBT + DDEBT \qquad (7.2)$$

Debt service payments comprise amortization and interest payments. However, service payments are modelled only in terms of interest payments. Contractual debt service obligation on each component of debt stock is therefore defined as the interest payments due on the particular debt. Contractual debt service obligation on private debt is thus given as:

$$PDTSEV_t = URS*(PDEBT_{t-1}) \qquad (7.3)$$

where URS is the US short-term interest rate used for calculating debt interest payments, and PDTSEV is the contractual interest payments on private external debt. Note, however, that the debt variables (PDEBT and ODEBT) are converted from their dollar values to naira (using the exchange rate).

Similarly, contractual debt service payments on the official debt are given as:

$$ODTSEV_t = FUR*(ODEBT_{t-1}) \qquad (7.4)$$

where FUR is the fixed US interest rate charged on the debt stock, and ODTSEV is the contractual interest payments on official foreign debt. Total contractual debt service obligation on external debt is therefore equal to the sum of (7.2) and (7.3) above:

$$TDTSEV_t = PDTSEV + ODTSEV \qquad (7.5)$$

It is assumed, however, that the government does not necessarily meet its contractual debt service obligations period by period. Depending on its economic circumstances, it may decide to reschedule some of the repayments and capitalize some or all of the interest arrears, or, in unusual cases of unexpected boom in economic activities, it may decide to retire some of the debts before they are due. It is assumed that the government always tries to service a proportion of its total contractual obligations, but it also increases all servicing as its revenues (total oil export receipts) increase. This actual or voluntary debt service behaviour may be thought of as the government's debt service reaction function (VOLSEV), and is specified thus:

$$\delta VOLSEV_t = \alpha_0 + \alpha_1 \delta TDTSEV + \alpha_2 \delta OILEXP \qquad (7.6)$$

where δ is first difference operator, and other variables are as previously defined.

The difference between the voluntary debt service payments and the contractual obligations may be thought of as involuntary lending, which is defined here as the accumulated arrears on debt service obligations (DARREA):

$$DARREA_t = TDTSEV_t - VOLSEV_t \qquad (7.7)$$

Changes in the private and official debt stocks can now be defined. Stock of debt can increase as a consequence of accumulated arrears and new issues. The current stock of private or official debt is defined as the stock of the previous period's stock of debt plus the proportion of debt service arrears accumulated on the debt source, plus any new issues. The accumulation of arrears on a particular debt stock, say private debt, is assumed to be proportional to the size of the debt source relative to the total debt stock. Changes in private debt stock, for example, are defined as:

$$PDEBT_t = PDEBT_{t-1} + \mu (DARREA) + NPDEBT \qquad (7.8)$$

where μ is the proportion of arrears owed to the foreign private creditors and NPDEBT is new debt borrowed from private foreign creditors by the government. Similarly, the stock of official debt is defined as:

$$ODEBT_t = ODEBT_{t-1} + \epsilon(DARREA) + NODEBT \qquad (7.9)$$

where ε is the share of total arrears owed to official creditors and NODEBT is new debt owed to official creditors. The sum of μ and ε equals unity.

Equations for the flow of new external private debt can now be specified. It is assumed that the inflow (net lending) or outflow (capital flight) of private capital depends on the private agents' assessment of the domestic economic conditions. It is hypothesized that the government's debt service reaction function is the indicator of the economy's overall creditworthiness and sound economic management. For example, if the government is rescheduling its debts and capitalizing interest arrears, private agents may fear that the actions may not be sustainable and the government may resort to any measure to service the debts in the future, including high taxation on capital, large devaluation of the local currency, etc. It may be expected then that private capital will tend not to flow in, but may even flow out of the economy. The flow of new loans to the domestic private sector therefore depends on government's debt servicing behaviour. It is assumed that the domestic private sector fully services its stock of external debt. External agents still attach a risk factor to their lending to the private sector because of the economy's high debt burden. The private to private capital flow is assumed to depend on the changes in the volume of non-oil exports, as well as government's voluntary debt service performance.

$$\delta NFPCAP_t = \alpha_0 + \alpha_1 \delta VOLSEV_t + \alpha_2 (EXP\text{-}OILEXP)_t \tag{7.11}$$

One probable interpretation of Equation 7.11 above is that even though capital is mobile, the economy faces an endogenous supply schedule for external financial resources. This supply depends on a forward looking assessment of Nigeria's debt-servicing capacity.

The flow of new loans from private external lenders to the government is a residual. The government's borrowing requirement (budget deficit) is assumed to be financed by borrowing either from the domestic market or abroad. But there are two kinds of external lenders the official creditors and private lenders. It is assumed that whatever the government is unable to borrow from the domestic market and official creditors is made up by borrowing from private lenders. New external debt to private foreign lenders is therefore given as:

$$NPDEBT = GDEF - (NODEBT + (GDEF*Dom)) \tag{7.12}$$

where NODEBT is flow of new official loans to the government, which is exogenously determined; GDEF is government's nominal deficit; and Dom is the proportion of deficits financed by borrowing in the domestic market.

We can now specify the equations for current account balances and net foreign assets. Current account balances are defined as the trade balance plus interest earnings on net foreign assets:

$$CURBAL_t = TBAL_t + AUR*NFA_{t-1} \tag{7.13}$$

where AUR is the average interest rate on the two sources of external debt, that is, URS + FUR = AUR.

$$AUR = (URS + FUR)/2 \tag{7.14}$$

Net foreign assets in turn is defined as:

$$NFA_t = TASETS - EDEBT \tag{7.15}$$

where TASETS is the total external assets of the economic agents in the economy (official and private), and other variables are as previously defined. The total external assets are defined as the sum of foreign assets owned by the private sector (PFA) and those held by the government (GFA).

$$TASETS = GFA + PFA \tag{7.16}$$

Default risk premium

It is assumed that the default risk premium does not follow a simple linear form. Risk premium on the external debt is hypothesized to depend on the multiplicand of the ratio of actual to contractual debt interest payments on external debt and the ratio of external debt to exports.

$$DRP_t = ((VOLSEV/TDTSEV)*(EDEBT/EXP*PGNP))*(AUR/100))^5 \tag{7.17}$$

where DRP is default risk premium, AUR is average interest rate for calculating interest payments on external debt.

Estimation results

Annual data for the period 1970-1991 are used in the estimation. The data series for the estimation span the period before 1986, that is, before the commencement of the structural adjustment programme. Given the supposedly significant structural changes after 1986, the stability of the time series data and the model results are of major concern. Besides, due to the non-stationarity of most macroeconomic time series, it is very important to avoid the problem of spurious correlation, or inconsistent regression that plagues econometric estimation when some or all of the individual series are non-stationary (see Adam, 1992; Nelson and Plosser, 1982; and Granger and Newbold, 1974).

Our major challenge in estimating the equations of the model, therefore, is to obtain a sensibly congruent model. By this, we mean a model that is interpretable in terms of the economic theoretic relationships being modelled and which also describes the short-run and long-run characteristics of the data in a statistically robust manner.

The theory of cointegration provides a powerful, formal framework for capturing the long-run relationship between non-stationary series (if such equilibrium relationship exists) within a stationary model (see Engle and Granger 1987). It is therefore a method of avoiding both the spurious and inconsistent regression problems that would otherwise occur with a regression of non-stationary data series. Cointegration is a long-run (static) specification theory, but it is also shown to be consistent with the error-correction dynamic specification (Engle and Granger, 1987). It can be a particularly useful approach in unrestricted (non-normalized) equations that are consistent with long-run equilibrium but may be characterized by considerable short-run dynamics. The reason for this is that the error-correction models capture the time series properties of variables, through the more robust dynamic structure allowed, whilst at the same time incorporating an equilibrium economic theory (Elbadawi and Schmidt-Hebbel, 1991).

Unit root tests conducted on the variables confirmed that most of the series have unit roots of order one (i.e., I-1 series). The small sample size for our estimation exercises (22) suggest that a lot of intuition and judgement are called for in trying to draw inferences from the cointegration and diagnostic tests. For example, the standard Dickey-Fuller and Augmented Dickey-Fuller tests for order of integration and cointegration have their critical values reported for sample sizes of at least 25 and 50, respectively. In spite of this limitation, the procedure is still attractive because it imposes some discipline in the estimation process. Following leads from the Masson, *et al* (1990), we proceeded to estimate most of the equations in error-correction forms. It has been shown that as long as such error-correction estimation is not strongly rejected by the time series structure of the variables involved, it can improve the chances of estimating the true parameters of interest. Most of the equations are in log-linear forms and the ordinary least squares is used as the estimator. Most of the variables are expressed in real terms.

The estimation results for the stochastic equations are presented in Appendix 3. The diagnostic statistics presented are the conventional ones: the t-statistics (in parenthesis), the Schwarz Criterion (SC), R^2, and the DW statistics (where relevant). Other diagnostic tests conducted for each of the equations include a test for the presence of autocorrelation and for the violation of homoscedasticity and normality assumptions. We also tested for the stability of the estimated coefficients by applying the Chow tests. All the tests, taken together, provide evidence that some of the individual equations may fairly characterize the underlying data generating processes.

Evaluation of model simulation properties

The dynamic properties of the model are also evaluated. This is because, as Pindyck and Rubinfeld (1981: 361) note, even if all the individual equations fit the data well and are statistically significant, we have no guarantee that the model as a whole, when simulated, will reproduce those same data series closely.

Methods of testing the overall quality of fit of general equilibrium models in any rigorous way are still in their infancy (Khan and Knight, 1991). Conventionally, evaluations of macroeconomic models emphasize the tracking ability of the model, that is, its ability to duplicate turning points. Statistics such as the mean-absolute-percentage errors (MAPE) or the Theil's inequality coefficients are computed, and the ability of the model's ex ante and ex post forecasts to track actual data closely is evidence of good performance. As Hendry and Richard (1982:4) argue, however, selecting models by the goodness of their dynamic simulation tracking performance is invalid in general and tells more about the structure of the models than about their correspondence to reality. It should be stressed that the choice of criteria for model evaluation depends crucially on the purpose of the model (Pindyck and Rubinfeld, 1981: 361).

Some scholars believe that for models designed for policy analysis of the what if kind, the model builder should ensure that: the individual equations are congruent models, and the simulated system is dynamically stable and exhibits sensible simulation properties. By this, it is required that the model should exhibit a tendency to return to equilibrium after any shock, and the model's results after a shock should be qualitatively consistent with theoretical priors. Since such model's are designed to ask what if questions, and not specifically for forecasting purposes, some what if kind of shocks are applied to the models and their results evaluated on the basis of their consistency with modelled relationships.

Our model is designed for analysis of the "what if" kind of questions. However, in spite of the seeming inadequacy of tracking performance as model evaluation criteria for this kind of model, we are still sensitive to the size of the simulated model's residuals. Tests on the actual and simulated baseline data for the period 1980-1990 show that the simulated baseline data for some of the endogenous variables have a tendency to duplicate

most of the turning points. Variables with the worst performance, at least as measured by the root-mean squared percentage errors of their forecasts are mainly identities, especially the debt variables. In particular, the stock of private external debt (PDEBT), stock of official external debt (ODEBT), voluntary debt service payments (VOLSEV) and real disposable income (YD) show root-mean squared percentage errors of 14.39, 12.84, 12.17 and 10.42, respectively. Surprisingly, the interest parity condition explained exchange rate variable closely well, with a simulation percentage error of 7.82. All the other variables have simulation percentage errors of less than 10. Furthermore, the calculated eigensystem for the model shows that the model is dynamically stable, as the eigenvalues for all the model's sub-sectors are less than unity in absolute terms. Eigenvalues for the external debt sector and monetary sector are 0.93 and 0.91 respectively. Values for the other sectors lie between 0.79 and 0.88.

Policy simulations and analysis of results

Specification of simulation rules

As indicated earlier, two versions of the model are created: one incorporates forward-looking, model-consistent expectations, while the other assumes that economic agents form their expectations adaptively. We then use two shocks that are critical for the success of a structural adjustment programme in Nigeria to shed further light on the properties of the model, as well as investigate the possible implications of these shocks for macroeconomic stability and growth in Nigeria. The shocks are: a programme of a permanent fiscal contraction, amounting to 2.5% of real GDP and an exogenous oil price shock amounting to 10% permanent increase in the nominal dollar export- price of oil. These shocks are designed to illuminate some of the issues that are of prime interest to policy makers and also central to a successful adjustment programme[6].

The two simulations are conducted for a period of 18 years, from 1993 through 2010. They are as follows[7]:

1. A permanent and immediate cut in the real value of government expenditures equivalent to 2.5% of real GDP. The cuts are assumed to be immediate in the sense that they are not phased-in shocks, and the implementation begins in the same year of the announcement, 1993. For economic agents in the model with forward-looking expectations, the shock is unexpected and therefore comes to them as a surprise; hence they have no time to act in anticipation of the fiscal contraction. Private decision makers are assumed to regard the programme of deficit-reduction as fully credible and after the initial surprise, begin to revise their expectations based on the future cuts.

2. A 10% permanent increase in the exogenously determined export price of oil. The shock is also assumed to be implemented immediately, starting in 1993.

It is important to make explicit assumptions about the stance of monetary policies when conducting specific policy shocks since alternative assumptions will produce significantly different results. In our simulations, monetary policy is assumed to be

unchanged in the sense that the target path for money stock is kept unchanged from the baseline target path. As indicated earlier, the intertemporal closure rule assumes that the income tax rate adjusts in order to prevent the stock of total government debt (domestic and external debt) from rising without bound relative to GNP. This rule enforces, over time, the long-run intertemporal budget constraints facing the government. As a policy rule, this constraint requires that current budget practices of the government be sustainable over time, and thus current debt liabilities must be serviced or repaid in the future. The constraint thus estimates the adjustments in taxes required to sustain any level of government consumption, given an exogenously specified target debt-to-GNP ratio. Furthermore, the modelling of the government's fiscal behaviour effectively enforces a fiscal and monetary rule that is analogous to operating an oil stabilization fund with sterilization. This is because, in our model, increases in government revenues resulting from increased oil exports or other sources are not spent; instead, the increased revenues lead to increased servicing of existing stock of debt.

We have presented the simulation results in a standard format. Simulations using the two model versions (that is, comparisons of the two expectations regimes) are conducted only for the fiscal contraction shock. Results for the oil price shock are reported only for the model-consistent version. This is because the qualitative differences between the two model versions have been demonstrated with the fiscal shock, and we do not want to repeat the comparison exercise for the oil price shock. For fiscal contraction shock, detailed results are plotted in charts in a manner to assist quick comparisons of the results of the two model versions. (The charts for the fiscal contraction simulations and the results for the oil price shock are in Appendix 4). For the fiscal contraction shock, the graph legends correspond to the two expectations regimes. For example, graph legend **ADAP** always refers to the version of the model with adaptive expectations, while the legend **CONS** always refers to the version with forward-looking, model-consistent expectations. Simulation results reported for most variables are given as percent deviations from baseline. Other variables are given as absolute deviations from baseline (for example, trade balances, and interest rates).

Analysis of simulation results

Consequences of deficit-reduction shock

The results under the two expectations show marked similarity in their qualitative outcomes but the magnitude of the multipliers and the timing of the effects show some differences that cannot be ignored. While the long-term results are similar for the most part, the short-run dynamic paths of some variables differ even though the policy shock is unannounced. Of course, it is not relevant to simulate announced policy shocks with

adaptive expectations model because agents in the model lack the forward-looking capability to react to future shocks until they are imposed. The driving force in the observed differences between the two model versions is the differential behaviour of the exchange rates. Economic agents in the forward-looking model expect a future exchange rate appreciation to offset the persistent decrease in the short-term rate as a result of the fiscal contraction[8]. As a consequence, exchange rate depreciates more under the model-consistent version than the adaptive expectations.

As expected, the cut in government expenditure, by decreasing aggregate demand, causes output, income and interest rates in both model versions to fall relative to baseline in the short run. Output and income, however, fall less under the consistent expectations because economic agents raise their expectations of future income. This induces private consumption and investment to rise more under consistent expectations than adaptive expectations. The reason is that consumers and investors project lower real interest rates in the future, and thus higher future real wealth streams and investment profitability. In the medium to longer term, income and output rise moderately above baseline. This is caused by the crowding-in effects of domestic expenditures induced by lower interest rates, prices and improvement in the economy's external competitiveness because of the depreciation of the naira.

Interest rate variables also fall under the two expectations regimes, due to observed contraction in the transactions demand for money as well as reduced pressure on available money supply resulting from lower government borrowing in the domestic financial market[9]. Another factor that could potentially depress the interest rate variables is the behaviour of the risk premium term. As a result of the higher exports and lower stock of government debt (domestic and external), the debt burden as well as the default risk premium and the risk adjusted domestic interest rate should fall.

The initial fall in income and output depresses prices below baseline. Price inflation is determined in an augmented Philips curve fashion, and movements of the economy towards full employment accelerate movements in prices. The fall in prices relative to baseline is modest, which is not surprising. This is perhaps caused by the offsetting effects of the factors determining the price level. The fall in domestic income would have depressing effects on prices whereas the depreciated naira, by raising import prices would act to tug prices upwards.

Private investment falls relative to baseline in the short run, perhaps due to reductions in government expenditures, which complement private investment spending, and the high cost of imported inputs induced by the depreciated naira. The lower prices, combined with lower interest rates, and increased private consumption spending drive private investment above baseline after the first year under consistent expectations but after two years under adaptive expectations.

The intertemporal fiscal closure rule enforced during the simulation results in the drastic fall in both the income tax rate and income tax revenues. The fall in income taxes combines with the fall in the price level to raise aggregate real disposable income sharply

and boosts private consumption expenditures[10]. Given the fall in long-term interest rates, consumers generally increase their consumption in both versions of the model.

The export sector gains a boost. Oil export seems to gain the most. Oil exports are expressed in real terms and given as an identity in both models. The change in oil exports seems to be induced by changes in prices rather than any real change in quantity exported. Since the shock does not induce changes in either the OPEC quota to Nigeria or the dollar denominated export price of oil, the variables driving the increases in oil export values are the depreciation of the exchange rate, which increases the nominal naira value of oil exports and the fall in the price level. The real value of oil exports, therefore increases even without any change in the exogenously determined export quantity and price. Thus, as exchange rate approaches the baseline and the price level rises above baseline in response to increases in output, real oil exports also fall to the baseline. The exports of primary commodities and manufactures exports seem to follow more the trends in domestic output than changes in exchange rate. These exports do not rise significantly following the depreciation of the naira, which, by raising the naira value of exports, should encourage the exporters. Supply of exports of manufactures and primary commodities may therefore be constrained more by domestic supply capacity than by price incentives. However, even though these export categories hardly moved above baseline, it is encouraging to observe that a fiscal contraction programme in Nigeria would have positive effects on exports generally.

Imports of goods and services declined relative to baseline in the short and medium terms in both model versions. This is principally because of the decline in aggregate demand and also the expenditure-switching effects of exchange rate depreciation. Imports of consumer goods decline less than imports of capital goods and raw materials in both models. Disposable income increases as a consequence of the reduction in the income tax rate, and this induces more imports than would otherwise be the case. However, as income and output recover from the initial fall and the exchange rate approaches baseline, demand for all imports rises. In the long run, imports rise above baseline. Observed trends in trade balance reflect the trends in imports and exports. Since exports are dominated by changes in oil exports, changes in trade balance follow leads from oil exports. Trade balance is positive throughout the simulation period, but improves more under model-consistent expectations because of expenditure-switching effects of the exchange rate depreciation.

The simulation results for the debt sector are interesting. The increase in exports and output increases the government's debt servicing capacity. Given the debt service reaction function, servicing of external debt improves relative to the baseline. The two model versions assume that domestic debt is always fully serviced at given domestic short term interest rate. Because the short-term rate falls relative to baseline, the total contractual debt service payments (domestic and external) also falls. Given the reduction in government fiscal deficits, and the improved debt service payments, the total stock of debt (domestic and external) also falls relative to baseline. Improvements in

government's debt service behaviour lower the default risk premium on external debt, restore external investors' confidence and lead to increased flow of financial resources from private external lenders to domestic private sector.

Consequences of oil price shock

The results of a 10% increase in the exogenously determined price of oil are presented in Figures 2a and 2b in the appendix. Simulation results have been reported for only the model-consistent expectations version of the model.

Aside from fiscal discipline, another major issue in the discussions between the government of Nigeria and the World Bank/IMF about maintaining macroeconomic stability have focused intensively on how to manage shocks from oil earnings. The issue is central to maintaining fiscal discipline since oil accounts for over 80% of government revenues and 90% of foreign exchange earnings. What the government does or does not do with the oil earnings is critical to the success of its overall economic management. More importantly, since exogenous shocks in oil prices are mostly unpredictable, policy discussions in recent times have focused on alternative scenarios for stabilization with or without sterilization, so as to smoothen government expenditures along an exogenously set target path and insulate the economy from the impacts (positive and negative) of the oil shocks.

In the past, the Central Bank of Nigeria bore the responsibility of accommodating fluctuations in foreign exchange flows. Oil related revenues (together with trade taxes, etc.) were deposited in the Federation Account and shared among the three tiers of government - federal, state, and local in a predetermined manner. Earnings from oil exports therefore elicited corresponding naira deposits that were distributed among the levels of government and some special funds. In the face of lax fiscal policy, and without a sterilization programme, the policy of monetizing any windfall from oil earnings increases money supply. Under a regime of flexible exchange rate and competitive financial system, this would have the effects of lowering interest rates, depreciating the exchange rate and causing inflation. The Central Bank's only recourse to controlling money supply has been to contract credit to the private sector, since the government maintains an unlimited overdraft with the Central Bank. Alternatively, the Central Bank has resorted to panicky, direct control measures designed to mop-up excess liquidity of the banking sector and causing the scarcity of loanable funds. This in turn sent interest rates to soaring as banks tried to make profits from limited lending, and the spread between lending and deposit rates widened. Private sector activities therefore bore the greater burden of adjustment to oil shocks, and got crowded out. So rather than being a positive shock, most windfalls from oil were apparently managed in ways that made them a 'curse'. The point being stressed is that the consequences of an oil price shock depend on the policy regime in place.

If our focus were to recast history and capture the consequences of oil windfalls during the last several years, then some modification of the present specifications have to be undertaken. Greater disaggregation and even endogenization of components of government expenditures would have to be undertaken. Money supply would have to be fully endogenous in the model, and the oil earnings money supply nexus would need to be spelt out. The other government's reaction functions (such as the central bank's credit ceiling reaction function) would have to be modelled explicitly. Our framework in the benchmark model does not aim to account for these linkages, since our emphasis is on what would happen if government implements the new proposals under a new policy environment? rather than with what happened in the past when the government implemented certain policies?. No doubt, for some policy analysis, it would be beneficial to endogenize components of government expenditure and experiment with specifications of endogenous money supply mechanism. Our present effort does not cover those specifications. Government expenditures (aside from the outlays for debt servicing) are exogenous in the model, and money supply is treated as largely exogenous (even though the central bank's interest rate reaction function is explicitly specified).

Our model and simulation exercise implicitly assumes a twin programme of stabilization and sterilization. Stabilization is assumed in that the government devotes the oil revenue windfall to the servicing of its debt and thus reduces the stock of debt. Sterilization is assumed in that the simulation assumes that extra revenue resulting from oil price increases does not lead to increased government expenditures nor increased money supply. The exogenous component of government expenditure is not increased as a result of the oil windfall. Our simulation results therefore demonstrate the potential consequences of such policy directions for macroeconomic behaviour.

The essential channels through which changes in oil prices affect the domestic economy are: impacts on government revenues, effects on total exports and thus on both the voluntary external debt service payments and default risk premium on external debt and changes in domestic income through impacts on trade balance.

Generally, the 10% increase in the nominal US dollar price of oil has beneficial effects on the economy. A 10% increase in oil price (given an almost 100% monetization into government revenues implied by our oil revenue equation) leads to a 10% proportionate increase in nominal oil revenues. But the depreciation of the exchange rate increases the nominal naira value of oil revenues. As the government revenues increase, the tax rate reaction function estimates a fall in income tax rates and hence in the income tax revenues relative to baseline.

Increased oil exports as well as improvements in other export groups improve the trade balance strongly and also positively affect domestic income. The increased exports lower the debt burden, increase the government's debt servicing capacity and, given, an unchanged monetary policy, lower the default risk premium on external debt. Risk adjusted domestic interest rate therefore falls relative to baseline. The exchange rate also

depreciates. Exchange rate depreciation combines with increased aggregate demand to push price levels above baseline.

Private consumption increases due to lower interest rates. Expectations of future lower taxes raise the consumers' expectations of future real income and thus increase their consumption. Private investment expenditures also increase in response to lower interest rate and expected profitability of investment due to increased aggregate demand. Manufactures and primary commodity exports hardly move above baseline because of the very small changes in both aggregate demand and exchange rate.

Our model assumes that private agents in Nigeria face an endogenous supply schedule for foreign loans that depends on the lenders' forward-looking assessment of the government's debt servicing capacity. External debt owed by the domestic private sector is assumed to be fully serviced. Foreign creditors, as risk averse investors, still look up to Nigerian government's debt servicing records as a measure of the overall solvency of the economy, and thus as the basis for extending loans to the domestic sector. An oil price increase that increases total exports also increases government's debt service performance. As a consequence, the flow of new external credit to the domestic private sector increases substantially.

In conclusion, the simulation results show that a policy regime that enforces stabilization with sterilization in the face of an oil export windfall would be generally beneficial to the economy. The inflationary impact of the shock is minimal - hardly above zero - but other macroeconomic aggregates show positive, albeit negligible, improvements. To estimate fully the relative advantages or disadvantages of stabilization and sterilization regimes as against the government's past fiscal and monetary responses would require counterfactual analysis. In this case, one would be asking, what would have happened if the government monetized the windfall, or spent it in some other ways?. Results of such a hypothetical scenario would be compared with the results of our regime that assumes sterilization of the windfall. It is intuitive to suggest that the consequences of an oil windfall in the economy would depend on what the government does with the windfall revenue.

IV Summary, conclusions and policy issues

In this study, a medium sized model of the Nigerian economy has been constructed and focused to capture the essential elements of a structural adjustment environment. Two versions of the model are created: one incorporates model-consistent, forward-looking expectations in the assets and goods markets, while the other constrains private economic agents to be adaptive in their expectations formation. Experiments with the two versions are designed to highlight some of the subtle issues that differences in assumptions about expectations formation might raise in evaluation of model results. Two illustrative simulations are conducted to evaluate the model's simulation properties and to shed light on the possible consequences of the much canvassed fiscal discipline, and also the potential effects of an exogenous oil price shock.

Policy issues emanating from the simulation results

A major question that motivated the fiscal contraction shock is whether fiscal discipline (a major policy proposal of the structural adjustment programme (SAP)) is consistent with the other broad objectives of the adjustment process, namely, macroeconomic stability (especially price stability), promotion of exports and dampening of imports through expenditure-switching effects of exchange rate changes and ensuring that the Nigerian economy resumes growth in the medium to longer runs. In the last few years, unsustainable fiscal budget deficits of the federal government have reached over 10% of GDP mark, with destabilizing consequences in the economy. Some analysts argue that reducing the fiscal deficit would depress the economy and be counter productive to the objectives of SAP.

The model developed in this study is a highly simplified one, and is not adequate to answer all the interesting questions that relate to a deficit reduction programme. For example, no distinction is made in the model between different types of government purchases, and government spending is treated as if it were all current consumption. All investment expenditures are treated as private investment. There is no gainsaying the fact that different government expenditures - be they capital investments or consumption - have differential effects on short and long-run economic growth. Thus, depending on which items are cut in the first instance, or whether there is a reallocation of expenditures

away from, say, consumption to investment spending, government fiscal behaviour could produce markedly differential effects on the economy.

However, in spite of the highly aggregative nature of the model, important insights can be gained from the experimental fiscal contraction shock. Some of the important conclusions are:

1. A programme of budget-deficit reduction is consistent with the objectives of maintaining price stability, improvements in external sector (depressing imports and boosting exports), and ensuring medium-to long-term growth of the economy. It can be observed that the short-run output and income loss (and perhaps the consequent unemployment) may not be as big as some protagonists of the 'inevitability of persistent deficits in order to maintain growth' would estimate. Indeed, if the budget cuts are accompanied by accommodating monetary policy (a logical assumption), then the estimated fall relative to baseline of income and output may be smaller, and the growth impetus may be larger. Reduction in budget deficit would permit the Central Bank of Nigeria to loosen the draconian squeeze on commercial bank credit to the private sector and thus remove the crowding-out effects of government fiscal deficits on the private sector.

2. The external trade sector improves moderately as a consequence of tightening the fiscal laxity of the government. Exchange rate depreciation, combined with increased domestic output, improves the external competitiveness of the export sector. Trade balance is positive throughout the simulation period, and this contributes to the positive growth of income.

3. The importance of price stability for economic growth, and for promoting other macroeconomic objectives of the government, cannot be overemphasized. Macroeconomic stability ensures that the private sector is protected from uncertainty and shocks, and this allows banks to develop a healthier portfolio. From a policy perspective, stability of the macroeconomic environment is a *sine qua non* for the sustainability of financial sector liberalization. Combined with lower and stable price inflation, competition among financial institutions would lower both the deposit and lending rates. Depositors would demand lower risk premiums than they would otherwise. Competition in the credit market would then promote the efficiency of investment and thus growth. Simulation results obtained for the fiscal contraction shock is consistent with these observations. Lower prices and nominal interest rates result in lower long-term interest rates, and thus a boost of private investment expenditure.

4. Differences between the short-run costs and long-run benefits of the fiscal deficit reduction point to the trade-off involved in deciding on a programme of deficit

reduction. Different deficit reduction plans are conceivable, and each of them would involve different 'mix' of costs and benefits[11]. For example, a full drawn-out, phased-in expenditure reduction spanning several years such as the one proposed by the transitional government of Nigeria can be undertaken. However, if a major segment of the private decision makers are forward-looking and regard the policy announcement as fully credible, the negative consequences of such phased-in deficit reduction may be less than expected. On the other hand, the government may decide on an accelerated deficit reduction within a short period of time. Depending on the composition of government expenditures and the items affected most by the cut, the negative impacts could be more or less than expected. Whatever the nature and mix of deficit reduction plans that are deemed most desirable, the critical element is the political will to undertake such tough measures. Short-run depression, which could accompany such a policy, may be so destabilizing politically that most governments (especially ones with a fragile political base) would be reluctant to undertake such policies. If the military regime in Nigeria could not muster the courage to discipline government spending, it is doubtful that a civilian administration (which is not generously endowed with such political courage) could conceivably embark on it, or do so in a manner to warrant the desired long-run benefits.

The results of the oil price shock are revealing in a number of other ways. The results show that an oil price shock (an increase in prices), aside from being inflationary, can have beneficial effects on a broad range of economic aggregates. But these effects are realized under an assumption that monetary policy and government spending are not changed from their baseline paths as a result of the shock. In other words, by assuming no changes in government's exogenous expenditures and money supply, our model effectively imposes a kind of sterilization regime. However, when government spends the windfall, and the Central Bank attempts to control money supply by crowding-out the private sector, the consequences may not be as encouraging as our simulation results show. This raises the question of how to cushion government spending in the face of unpredictable, and sometimes frequent, oil price shocks.

The federal government of Nigeria seems to be aware of the necessity for some sort of a stabilization mechanism and since 1989 has tried to implement a stabilization fund for oil revenues. The programme is intended to achieve two major objectives: first, to stabilize economic activity and smooth fiscal spending by increasing reserves (or decreasing debt) in times of high oil revenues and by running down reserves when oil revenues decline; second, to sterilize money supply increases resulting from the increased oil revenues by not spending the naira counterpart funds of new reserves (stabilization with sterilization). Our simulation results imply that both regimes- stabilization with sterilization are imposed, in the sense that the windfall does not lead to increases in government expenditures and money supply, but rather results in increased debt service payments and thus reduces the stock of government debt.

One major obstacle to a credible implementation of a stabilization scheme is the lack of political will to resist spending. For example, in 1990 the federal government reserved much of the oil windfall resulting from the Iraqi war in its stabilization account. In late 1990 the government spent much of the naira counterpart fund, and this increased domestic money supply by an unprecedented 40% during the year in the face of unchanged reserves. The naira depreciated rapidly in 1991 and inflation soared. Reneging on announced or agreed policies is a major failure of the government of Nigeria in its attempt to structurally adjust the economy. Our simulations show that a stabilization and sterilization programme in the face of an oil windfall could be potentially beneficial to the economy. Failure to fully implement such a policy regime therefore is not a good testimonial for the government's economic management skills.

Expectations formation and policy choices

Simulation results reported for the fiscal shock in this study show that the manner of expectations formation by private economic agents can affect the nature of the results obtained in any simulation exercise. For example, when agents are forward-looking in their expectations, a deficit reduction shock would dampen output for only two years whereas the depression of output is more prolonged if agents are backward-looking. The qualitative results (i.e., the overall direction of impacts) are comparable, but the differences in the size of multipliers are too significant to be ignored.

The development of rational expectations assumptions in macroeconometric modelling has come a long way. Protagonists of rational expectations have vigorously criticised the clearly inadequate treatment of behaviour as being solely backward-looking, and demonstrated the superiority of forward-looking behaviour as an alternative reality. It is assumed that movements of the supply, demand and price relationships depend on expectations of the future. For example, if investment and consumption depend on real interest rates, then they implicitly depend on the expected price level in the future. Also, long-term interest rates depend on expectations of future short-term interest rates, and therefore, on expectations of future monetary and fiscal policies. If interest rate differentials depend on expected changes in exchange rates, then expectations of future exchange rates affect interest rate behaviour. Therefore, private economic agents who are forward-looking in their expectations would take into account the likely effects of future policies in their present behaviour (Soludo, 1992).

In general, however, the effects of policy shocks when agents are forward-looking depend on the size of the shock, whether the policy changes are announced or unannounced and whether the shock is persistent or temporary. When policy changes are perceived as temporary, rational economic agents regard them as transitory and may not react to them as much as they would if the shock is sustained. This is one reason the

reaction formation of economic agents under model-consistent expectations would dampen the effects of temporary shocks and accelerate the effects of sustained policy changes.

What is the implication of these alternative treatments of expectations for model selection and interpretation of model results for policy makers and analysts in a developing country such as Nigeria? Put differently, given the rather heroic assumptions underlying model-consistent expectations, are the assumptions relevant for policy analysis in Nigeria? Definitive answers to these questions cannot be given. On one hand, it is easy to dismiss rational expectations (which presupposes credibility of announced policies, and perfect information) as inapplicable in Nigerian circumstances of uncertainties, structural transformations and mistrust of government policies. On the other hand, to simply assume (as most people are used to doing, sometimes even without a thought about the implications of such assumptions) that the economic agents in Nigeria are so naive and so stuck with their past that they hardly take account of the future in their present economic calculations, is fantastic. Backward-looking behaviour implies that the past is the best predictor of the present and the future. In circumstances of structural transformation, irregularities and uncertainties about policy directions, reliance solely on the past as a guide to economic behaviour is not realistic.

It may also not be realistic to ignore the anticipatory behaviour of many economic agents especially in the financial, distributive and productive sectors of the economy. Some firms are known to value their assets at their expected replacement cost rather than the actual (past) cost. Pricing behaviour of some firms (especially ones that depend heavily on imported inputs) can be realistically characterized as depending on the expected future cost of inputs, and thus on some expected future exchange rate. When firms decide to either accumulate or decrease stocks in anticipation of future policy announcements in the annual budgets, they cannot be said to be solely backward-looking. In Nigeria, past experiences show that prices have jumped in anticipation of policy changes, especially when government announces wage increases. One may argue that the size of economic agents exhibiting these anticipatory behaviours is small relative to the economy. However, the impacts of their behaviour may not be too trivial to be ignored by policy makers and analysts.

These expectations regimes are nevertheless extremes, and the actual behaviour is probably somewhere in the middle. It is intuitive that economic agents take their decisions on the basis of both hindsight and foresight. It is suggested that future advances in macroeconomic modelling incorporate ideas about appropriate strategies to construct the half-way house between these extreme expectations regimes.

In the present study, experimentation with the two expectations regimes is more for demonstrative purposes than an attempt to prove that one extreme assumption is superior to the other. If the exercise serves any purpose at all, it is to sensitize policy makers and analysts about the implications of entertaining either of these assumptions in formal models, and therefore to be cautious in interpreting multipliers generated by either of these model versions. For practical purposes, since these expectations are extremes and

thus bracketing the reality, policy makers can realistically infer that the true behaviour is somewhere in between the two results. A third purpose is to flag the issue for macroeconomic analysts, especially those who construct and use economy-wide models, and hope that further research efforts can be devoted to improving economists' characterizations of the economy through models.

Aside from the policy issues illuminated by the representative simulations reported in this study, it is important to note that the major contribution of the work lies more with the potential uses of the model than what it has been used to do in this study. As indicated earlier, the model attempts to capture the essentials of the SAP environment in Nigeria, and thus some of the current issues in the adjustment process can be analyzed with the model.

Potential uses of the model

The model is to be used as tool-kit, and can be potentially useful to the staff of the Central Bank of Nigeria, Ministry of Finance, Budget and Planning Ministry, and policy analysts. With some skills, the model can be extended and simulated to illuminate some issues of concern to policy makers. The model-consistent version, for example, can be used to investigate possible implications of announced versus unannounced policy shocks. As Nigeria makes a transition to civilian rule, the importance of announced versus unannounced policies cannot be ignored. This is because announced policies would usually take time to be approved by the National Assembly, and it is not unreasonable to expect economic agents to act in anticipation of the effects of the policies. Phased-in policies, such as the budget deficit reduction plans announced by the transitional administration, can be analysed with the model. A major debate has lingered on about the potential consequences of removing the subsidy on petroleum products in Nigeria. Whereas the model is not designed to handle distributional problems arising from such a policy, it is adequate to illuminate some of the short-and long-term macroeconomic effects of such a policy shock.

One major strength of the model is that it is flexible, and several policy rules can be entertained as simulation rules. Intertemporal sustainability of policy regimes is a crucial feature of the model. When the intertemporal closure rules are enforced, the model is flexible to estimate (for use of policy makers) the necessary adjustments (costs) of alternative policy scenarios. That is, the model shows what has to adjust in order for a particular policy action to be sustainable. The treatment of intertemporal closure rules is one of the novel aspects of the model, and it is a special feature of model-consistent models.

Limitations of the model and agenda for further research

It is unrealistic to aspire to build a 'super-model' of a developing economy - one that captures all reality and leaves no room for further modifications. As every economist knows, given the present state of knowledge in the economics profession, every effort in building a general-equilibrium model of an economy is, like every work of human creation, an unfinished business. Every effort should be seen as a stage in a process, but the model-builder must be satisfied that each stage fulfils definite purposes, and deepens understanding of *some* aspects of the economy in question. These caveats have influenced our current efforts.

Every model reflects the builders' perceptions of the economy being modelled. Economists are not agreed about the correct characterization of the workings of economies, and this is also reflected in the assumptions we make in the process of economic analysis and model-building. Our methodological inclination in building the model is to start with a small model whose results we can understand. In the process, we have made several assumptions about economic behaviour in Nigeria that contradicts historical experience but are nonetheless analytically helpful and revealing.

It should be emphasized that revisions and extensions of the model will be a continuous process. As it is now, the model is in a highly aggregative form and has several deficiencies. Even though we tried to graft both the neo-classical and Keynesian frameworks into the modelling process, the Keynesian bent of the model is evident. Furthermore, we recognize the need for further research and refinements of the supply sector; greater disaggregation and alternative modelling assumptions of the monetary sector; better treatment of the external sector (imports and exports); and alternative modelling of exchange rate behaviour. The external debt sector of the model can be refined to take account of issues related to debt buy-backs, valuations in debt prices in the secondary debt market, etc. Experiments with disaggregation and endogenization of different government expenditure components can also be undertaken. Some of these improvements are taken up in a follow-up study sponsored by the AERC and entitled "Choice of Optimal Mix of Fiscal and Monetary Policy Rules: Evidence from A Model of Nigeria".

Notes

1. See the 'Introduction' in Khan, Montiel' and Haque (1991) for detailed discussion of the elements of SAP.

2. We are aware of the current efforts by the CEAR group to develop a model as input into the Perspective Planning efforts of the Nigerian federal government, and a model of Nigeria also being developed by the World Bank. However, we are informed during preliminary discussions with some of the scholars involved in these projects that the models emphasize the real sector and the financial sector is largely ignored. This bent reflects the specific objectives of the modellers.

3. This is the actual debt service payments made by the government to service its stock of external debt. It is not necessarily equal to the contractual obligations because the government may not meet the contractual payments, and the difference is the interest arrears, which is often capitalized. The external debt section of this paper provides further duscussion on this variable.

4. This is similar to the specification by Meredith (1989-20). However, instead of a bond maturity period of ten years, a period of eight years is assumed in this model. This approximates the maturity period of the development stocks in Nigeria.

5. This reaction function is similar to the one specified for the EMS countries in Masson, et al (1990), which is also a variant of the rule used by Edison, Miller and Williamson (1987). Investigating the implications of a version of the model with the assumption of a target-zone fixed exchange rate regime and the corresponding monetary policy reaction function is a potentially beneficial line of research. The current model does not investigate those, but instead assumes a flexible exchange rate regime.

6. For example, the fiscal indiscipline of the Babaginda administration is widely acknowledged as the bane of the current adjustment sprocess in Nigeria. The unsustainably burgeoning fiscal deficit is seen as a major destabilizing factor in the economy and has been a source of concern to both domestic economic agents and external investors and donor agencies. It is therefore not surprising that the

transitional governemtn headed by Mr. Shonekan announced a long-term programme to reduce the fiscal budget deficit to about 3% of GDP by 1997. Since the present study is designed to evaluate the consistency of some of the proposals for fiscal discipline under SAP, with other objectives of promoting trade and growth, a budget deficit reduction shock is considered a reasonable experiment.

7. The simulations are conducted with PCSIM, a Fortran-based software currently being maintained at the Brookings Institution, Washington, D.C. It should be observed that solving large non-linear models incorporating forward-looking, model-consistent expectations can entail technical complications. The procedure used to solve the model is an application of the Fair-Taylor extended-path technique (see R.C. Fair and J.B. Taylor, 'Solution and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectation Models', (*Econometrica* 1983).

8. Recall that interest parity condition adjusted for default premium on debt stock determines exchange rate in the model, and an absence of capital controls is assumed. Therefore, the vairable that adjusts to ensure zero balance in the balance of payments is primarily private capital flows.

9. This result is intuitive given the assumptions underlying the modelling of the monetary sector of the model. The Central Bank is assumed not to purchase government bonds, and so fiscal deficits must be financed by borrowing from the domestic private financial institutions and abroad. Deficit financing therefore raises domestic interest rates and deficit reduction is expected to have opposite effects in the model, given a simulation rule of 'unchanged' monetary policy. This is a realistic rule to enforce given the current prosposals for deficit reduction and indirect monetary policy instruments in Nigeria.

10. It should be observed that different specifications of this intertemporal closure rule would produce results that may be significantly different from some of the results obtained from the simulation - at least the size of the multipliers may be significantly affected.

11. We plan to experiment with alternative simulations of the different deficit-reduction programmes in the future. This will be done with versions of the model that incorporate certain revisions and improvements on the model structure and properties.

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Appendix 1. Data sources and limitations

Care has been taken in the collection of data to use specific sources for different kinds of data in order to ensure consistency. As much as possible, we have relied on publications of the Central Bank of Nigeria for data on the financial sector, interest rate, exchange rate, domestic debt, output, government finances and external trade. Such publications include the *Annual Report and Statement of Accounts*, *Nigeria's Principal Economic and Financial Indicators*, and particularly, the *Statistical Bulletin* (volumes 1 and 2, 1990 and 1991). The World Bank's *World Tables, World Debt Tables* and the IMF's *International Financial Statistics* are the major sources of data on external debt.

Data on oil production, export, domestic consumption and export prices are sourced from the *Annual Statistical Bulletin* of the Nigerian National Petroleum Corporation. Historical nominal prices of some petroleum products were obtained from the sales files of some sampled petrol filling stations. Other supplementary sources of data are from publications of the Nigeria's Federal Office of Statistics: *Annual Abstract of Statistics; Digest of Statistics; and Economic and Social Statistics Bulletin*. Labour statistics, among others, are sourced from these publications.

It can reasonably be argued that the quality of a model's simulation results is as good as the quality of data used in calibrating the model. This can be particularly true for developing countries where the quality and availability of macroeconomic data are highly suspect. In Nigeria in particular, disparities in the values of data collected from different sources, and the absence of data series for several years, make macroeconomic research a daunting task. For many series, blank columns for several years are a common feature of major statistical publications. Collecting macroeconomic data often entails personal visits to the agencies responsible for documenting information on these series, and it can be a lot of effort trying to extract the needed data from files, reconcile the numerous inconsistencies and extrapolate some series to fill blank columns.

Furthermore, the incomparability of data from different sources, or even data from the same source but published at different periods, is a frustrating experience. A lot of care and discretion are therefore needed in deciding which sources to rely on for different series. In spite of all the caution exercised, it is still difficult to vouch for the quality or reliability of the data series used in the study. Multipliers emanating from our simulations, and indeed from most macroeconomic analysis with Nigerian data, have to be taken with caution.

Macroeconomic research cannot, however, be halted in many countries because of bad data. Policymaking and policy analysis still go on in these countries on the basis of the same bad data. There is too much at stake for economists to simply wring their hands

in despair because of bad data. Indeed, macroeconomists in developing countries can play a critical role in ensuring the evolution, in the longer-term, of better quality data bases by interacting actively with the data collection agencies, pointing out which data are needed and in what form. Basic errors and inconsistencies in data series should be continually brought to the attention of the agencies, and this positive interaction may result in greater efficiency over time. In the long run, quality of data may be improved. Improvement is the goal since quality of macroeconomic data in general is a matter of degree.

Aside from quality of data, an important decision has to be made with respect to methodology for extrapolating data beyond the period for which they are available. This is an important stage, but one that calls for a lot of judgement. The only guide to preparation of out-of-sample data bases is one's judgement about future course of policies, developments in the economy or assumptions about what 'sensible' future paths of economic behaviour would look like.

A number of decisions have been made about post-sample projection of data. First, we chose to limit the projection of data into the future to the year 2015. Even though the period is not long enough for investigations of the model's steady state properties, we believe it is enough to make inferences about the model's long-run simulation behaviour. Second, a decision was made to distinguish between periods in the future data series. There is a transitional period that spans 1993 through the year 2000, and a second phase that runs from 2001 through 2015. During the transitional period, a three-year moving average growth rate of GDP, imports, exports, consumption and private expenditures is assumed to continue. From the year 2001, the economy is projected to grow at an annual rate of 3.5%, and other major macroeaggregates are assumed to maintain their constant ratios to GDP. Deficit reduction programme is assumed to be enforced in the remainder of the 1990s, with the government running surpluses in the several years after the year 2000 and then balancing its budget annually. In the longer term, a zero trade balance is assumed after a sustained period of trade surpluses to offset earlier deficits. The exchange rate is projected to stabilize around 25 naira to a US dollar. Prices and interest rates are projected to stabilize after the year 2005, and stable but positive real rates to be maintained thereafter. All these assumptions, though arbitrary, are predicated on the need to satisfy intertemporal behavioural constraints. The government cannot borrow forever, and accumulated debts have to be serviced. Budget or trade deficits today have to be offset by surpluses tomorrow. The choice of growth rates may be arbitrary, but once chosen, other variables are projected in a manner consistent with the assumed growth rates of certain aggregates.

Appendix 2. List of variables

Endogenous variables

AUR	Average interest rate on the two sources of external debt
CAIMP	Capital goods imports
CAPUTL	Capacity utilization rate
CNIMP	Consumer goods imports
CP	Private consumption expenditures
COMTAX	Company or corporation income tax
CURBAL	Current account balances (in naira)
CUSTAX	Customs and excise duties
DARREA	Accumulated arrears on external debt service obligations
DDEBT	Stock of government's domestic debt
DPIT	Total imports price in domestic currency.
DPXT	Total exports price
DRP	Default risk premium on external debt
DSERV	Service payments on domestic debt
EDEBT	Total stock of external debt
ER	Nominal exchange rate (naira per US dollar)
ER^e	Expected nominal exchange rate
EXP	Total real exports
GDEF	Government nominal current budget deficit
GDP	Real gross domestic product
GEXP	Total nominal government expenditures
GNP	Real gross national product
GTAX	Total nominal government revenues
GTAXF	Total federally retained revenues
IMP	Total real imports
INF	Inflation rate
INFe	Expected inflation rate
INV	Private investment expenditures
KP	Gross private capital stock
LF	Demand for labour force
LR	Long-term (lending) interest rate
M	Demand for real money balances

MAEXP	Export of manufactures and semi-manufactures
NFA	Net foreign assets (in naira)
NFPCAP	Private to private capital flows
NPDEBT	New inflow of external private lending to the government
ODEBT	Stock of external debt owed to official sources
ODTSEV	Contractual debt service obligations on official debt
OILEXP	Total oil export receipts
OILTAX	Revenues from oil sources (petroleum profit tax)
OTHOIL	Other oil related revenues
PDEBT	Stock of external debt owed to private creditors
PDTSEV	Contractual service obligations on debt owed to external private creditors
PGNP	Domestic price level (GNP deflator)
PMEXP	Export of primary commodities
REXR	Real exchange rate
RLENR	Real long-term interest rate
RSR	Real short-term interest rate
DRS	Short-term interest rate
TASETS	Total external assets (private and public)
TBAL	Trade balance (in local currency)
TDEBT	Total government debt stock (domestic and external debt)
TDTSEV	Total contractual debt service obligations on external debt
TRATE	Average income tax rate
TSERV	Total debt service payments (domestic and external)
UE	Unemployment rate
VOLSEV	Voluntary or actual debt service payments
WG	Average wage rate
YCAP	Capacity (potential) output
YD	Real disposable income
YTAX	Nominal income taxes

Exogenous variables and parameters

Dep.	Depreciation rate on capital stock
Dom.	Proportion of government current deficits financed by borrowing in the domestic market
DPIM	Exogenously determined price of imports (valued in dollars)
DPOIL	Price of oil products in the domestic market
DUM	Dummy variable used to adjust tax rate reaction function

Fed.	Share of the federal government in the federation account
FUR	Fixed interest rate on external debt owed to official sources
G	Exogenous real government expenditures
GFA	External assets of the government (in naira)
LF^s	Supply of labour force
MT	Target money stock (money supply)
NODEBT	New inflow of external loans to government from official creditors
PCOM	Primary commodity prices
PCR	Banking sector credit to the private sector
PFA	Private sector's stock of foreign assets
POIL	Export price of oil (in US dollars)
PQOTA	OPEC determined oil production quota for Nigeria
T	Trend term that captures the effect of technical progress
TarifM	Average tariff rate on imports
TarifX	Average tariff rate on exports
TDEBTT*	Exogenous target level of government debt (domestic and external)
TRASF	Government transfers
URS	US short-term interest rate, also used for calculating debt interest payments
URSR	US real short-term interest rate

Appendix 3: Estimation results

Results of the estimated equations are presented below. Figures in parenthesis are the t-statistics, σ is the equation standard error, SC is the Schwarz Criterion, and R^2 is the usual R squared statistics.

1. Private Consumption Expenditure:

$$Ln\left(\frac{CP}{CP_{t-1}}\right) -0.0117 +0.639\ Ln\left(\frac{YD}{YD_{t-1}}\right)+0.087\ Ln\left(\frac{YD_{t-1}}{CP_{t-1}}\right) -0.2677\ RLR_t$$

$$(0.78) \qquad (5.74) \qquad (2.08) \qquad (1.95)$$

$$R^2 = 0.88 \qquad \sigma = 0.073 \qquad SC = -4.76$$

2. Private investment expenditures:

$$Ln(INV) = 2.58 + 0.5731Ln(GDP)_{t-1} -0.0936Ln(REXR) -$$
$$(1.88) \qquad (3.31) \qquad (1.79)$$

$$-0.1027Ln(RLENR) + 0.2615Ln(KP)_{t-1} + 0.1262Ln(KG)_{t-1}$$
$$(1.53) \qquad (3.91) \qquad (1.97)$$

$$R^2 = 0.96; \ DW = 2.28.$$

3. Oil tax revenue:

$$Ln\ (\frac{OILTAX}{OILTAX_{t-1}}) = 0.027 + 0.937\ Ln\ (\frac{OILEXP * PGNP}{OILEXP_{t-1}PGNP_{t-1}}) +$$

$$(1.12) \qquad\qquad (14.93)$$

$$0.084\ Ln\ (OILEXP * \frac{PGNP}{OILTAX_{t-1}})$$

$$(1.89)$$

$$R^2 = 0.94 \qquad \sigma = 0.09 \qquad SC = -2.21 \qquad DW = 1.74$$

4. Other oil revenues:

$$Ln\ (\frac{OTHOIL}{OTHOIL_{t-1}}) = -0.659 + 0.288\ Ln\ (\frac{GDP * PGNP}{GDP_{t-1} * PGNP_{t-1}}) +$$

$$(2.11) \qquad\qquad (4.59)$$

$$0.1012\ Ln\ (\frac{GDP_{t-1} * PGNPt-1}{OTHOILt-1}) + 0.0397\ Ln\ DPOIL-t$$

$$(1.33) \qquad\qquad (6.01)$$

$$R^2 = 0.68 \qquad \sigma = 1.63 \qquad DW = -2.07 \qquad SC = 1.56$$

5. Corporation or company tax:

$$Ln(\frac{COMTAX}{COMTAX_{t-1}}) = -0.260 + 0.168 Ln(\frac{GNP * PGNP}{GNP_{t-1} * PGNP_{t-1}}) + 0.044 Ln(\frac{GNP * PGNP}{COMTAX})_{t-1}$$

(1.08)   (3.34)   (1.09)

$R^2 = 0.68$ $\sigma = 0.23$ $SC = 1.45$ $DW = -2.31$

6. Manufactures exports:

$$Ln(\frac{MAEXP}{MAEXP_{t-1}}) = -0.1735 + 0.4464 \, Ln(\frac{\Theta \, GDP}{\Theta \, GDP_{t-1}}) +$$

(1.41)   (3.19)

$$0.097 \, Ln(\frac{\Theta \, GDP_{t-1}}{MAEXP_{t-1}}) + 0.1568 \, Ln(\frac{REXR}{REXR_{t-1}}) + 0.189 \, Ln(\frac{PXM}{PGNP})$$

(2.02)   (1.48)   (1.87)

$R^2 = 0.71$ $\sigma = 0.24$ $DW = 2.17$ $SC = -1.94$

7. Primary commodities:

$$Ln \ (\frac{PMEXP}{PMEXP_{t-1}}) = -0.1574 + 0.2635 \ Ln \ (\frac{GDP_{t-1}}{PMEXP_{t-1}}) +$$

$$(-0.88) \qquad (1.88)$$

$$0.4837 \ Ln \ (\frac{GDP}{GDP_{t-1}}) +0.109 \ Ln \ (\frac{REXR}{REXR_{t-1}} +0.148 \ Ln \ (\frac{PCOM}{PGNP})$$

$$(2.78) \qquad (1.68) \qquad (2.19)$$

$$R^2 = 0.69 \qquad \sigma = 0.2 \qquad DW = 2.13 \qquad SC = -2.61$$

8. Imports of consumer goods:

$$Ln \ (\frac{CNIMP}{CNIMP_{t-1}}) -0.193 + 0.257 \ Ln \ (\frac{YD}{YD_{t-1}}) -0.4229 \ Ln \ (REXR_t)-$$

$$(1.12) \qquad (2.52) \qquad (2.16)$$

$$0.168 \; Ln \; (\frac{REXR}{REXR_{t-1}}) \; +0.206 \; Ln \; (\frac{YD_{t-1}}{CNIMP_{t-1}})$$

$$(1.93) \qquad\qquad (2.09)$$

$$R^2 = 0.77 \quad \sigma = 0.16 \quad DW = 1.78 \quad SC = -3.75$$

9. Imports of capital goods and raw materials:

$$Ln \; (\frac{CAIMP}{CAIMP_{t-1}}) \; =-0.2276 \; +0.545 \; Ln \; (\frac{GDP}{GDP_{t-1}}) \; +$$

$$(2.85)$$

$$0.382 \; Ln \; (\frac{GDP_{t-1}}{CAIMP_{t-1}}) \; -0.4108 \; Ln \; (REXR) \; -0.241 \; (\frac{REXR}{REXR_{t-1}})$$

$$(3.08) \qquad\qquad (2.01) \qquad\qquad (1.89)$$

$$R^2 = 0.89 \quad \sigma = 0.106 \quad DW = 1.87 \quad SC = -4.14$$

10. Money demand equation:

$$Ln \ (\frac{M}{PGNP}) = 0.1074 + 0.1506 \ Ln \ (GNP) + 0.7889 \ Ln \ (\frac{M}{PGNP})_{t-1} - 0.0054DRS$$

$$(1.18) \qquad (2.32) \qquad (2.48) \qquad (-2.03)$$

$$R^2 = 0.94 \qquad \sigma = 0.09 \qquad DW = 1.97 \qquad SC = -4.45$$

11. Monetary policy reaction function (short-term nominal rate):

$$DRS = DRS_{t-1} + 0.1044 \ (\ DRS_{t+1} - DRS_{t-1} + \frac{0.333 \ Ln \ (\frac{MT}{M})}{-0.0054})$$

12. Nominal long-term rate (adaptive expectations):

$$LR = 0.400DRS + 0.6000LR_{t-1}$$

13. Capacity output:

$$Ln(YCAP) = 0.7946 + 0.3478Ln(KP) + 0.6522Ln(LAB) +$$

$$(2.02) \qquad (3.79) \qquad (4.46)$$

$$0.2092Ln(KG) + 0.0371T$$

$$(2.26) \qquad (1.73)$$

$R^2 = 0.93$; Restricted to constant returns (sum of coefficients on KP and LAB equals unity).

14. Labour demand:

$$\Delta LFD = -0.1034 + 0.2354 \Delta CAPUTL - 0.2005 \Delta WG + 0.6982 \Delta LFD_{t-1}$$

$$\quad\quad (-0.27) \quad\quad (3.13) \quad\quad\quad (-1.87) \quad\quad (2.18)$$

$$R^2 = 0.69 \quad\quad \sigma = 0.22 \quad\quad DW = 2.09 \quad\quad SC = -3.88$$

15. Wage rate:

$$Ln(\frac{WG}{WG_{t-1}}) = -0.0149 + 0.0243 \ (\frac{INFe}{INF} + 0.624 \ Ln \ (\frac{GDP}{GDP_{t-1}}) - 0.033 \Delta UER$$

$$\quad\quad (-2.54) \quad\quad (1.92) \quad\quad\quad\quad (2.68) \quad\quad\quad\quad (-2.02)$$

$$R^2 = 0.82 \quad\quad \sigma = 0.064 \quad\quad DW = 2.23 \quad\quad SC = -5.12$$

16. Inflation rate:

$$INF = -0.0055 + 0.1853 \ Ln \ (\frac{WG * PGNP}{WG_{t-1} \ PGNP_{T-1}}) + 0.385 \ Ln \ (\frac{DPIT}{DPIT_{t-1}}) \ + INF_{t-1}$$

$$\quad\quad\quad (2.09) \quad\quad\quad\quad (2.26)$$

$$0.2259 \; Ln \; (\frac{CAPTUL}{CAPTUL_{t-1}}) \; +0.583$$

$$(2.12) \hspace{3cm} (1.93)$$

$$R^2 = 0.88 \hspace{1cm} \sigma = 0.11 \hspace{1cm} DW = 2.03 \hspace{1cm} SC = -3.69$$

17. Voluntary or actual external debt service payments (reaction function):

$$VOLSEV=0.120YCAP+0.48(\blacktriangle YCAP)+0.100((\frac{AUR}{100} * PDEBT_{t-1})-\frac{AUR}{100} * NODEBT_{t-1})$$

18. New flow of private external lending to the private sector:

$$\blacktriangle NPCAP=0.740+0.114 \blacktriangle (TEXP-OILEXP)+0.0418 \blacktriangle VOLSEV+0.3718 \blacktriangle NPCAP_{t-1}$$

$$(2.94) \hspace{2cm} (1.05) \hspace{3cm} (1.62) \hspace{2cm} (2.38)$$

$$R^2 = 0.63 \hspace{1cm} \sigma = 0.29 \hspace{1cm} SC = -1.78$$

Appendix 4. Simulations results figures

Figure 1-A: Fiscal contraction shock
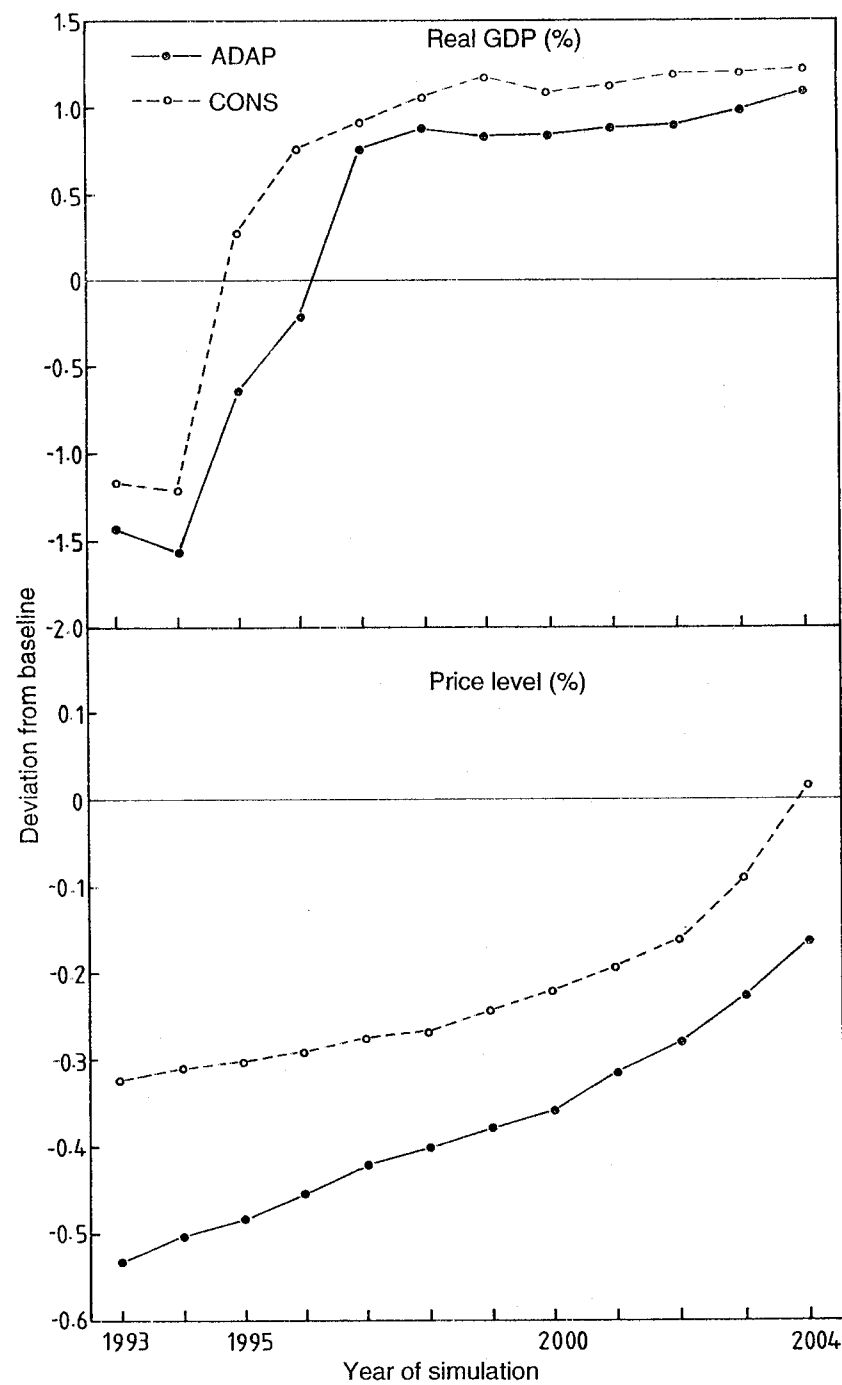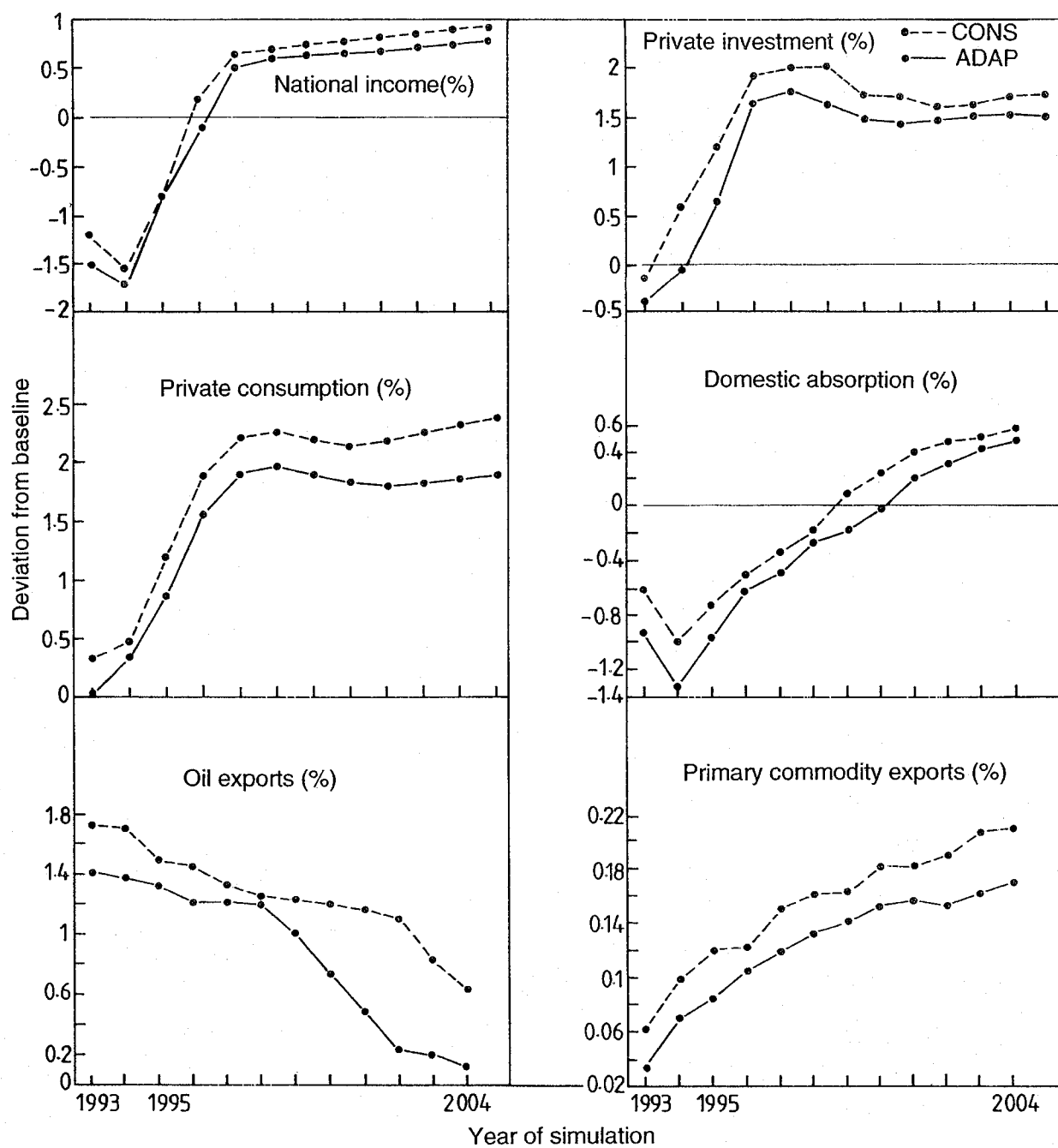
Figure 1-B: Fiscal contraction shock .... contd
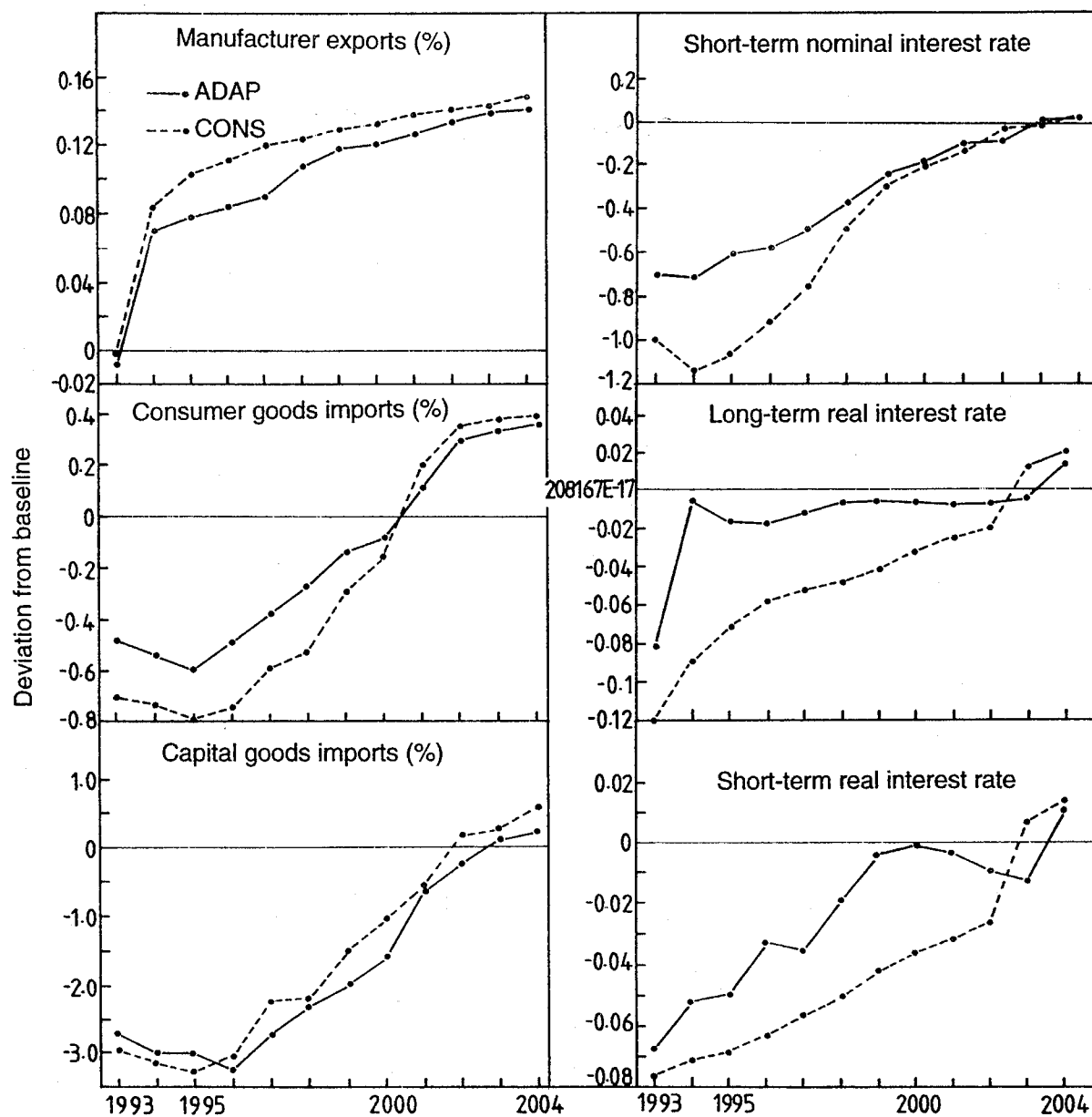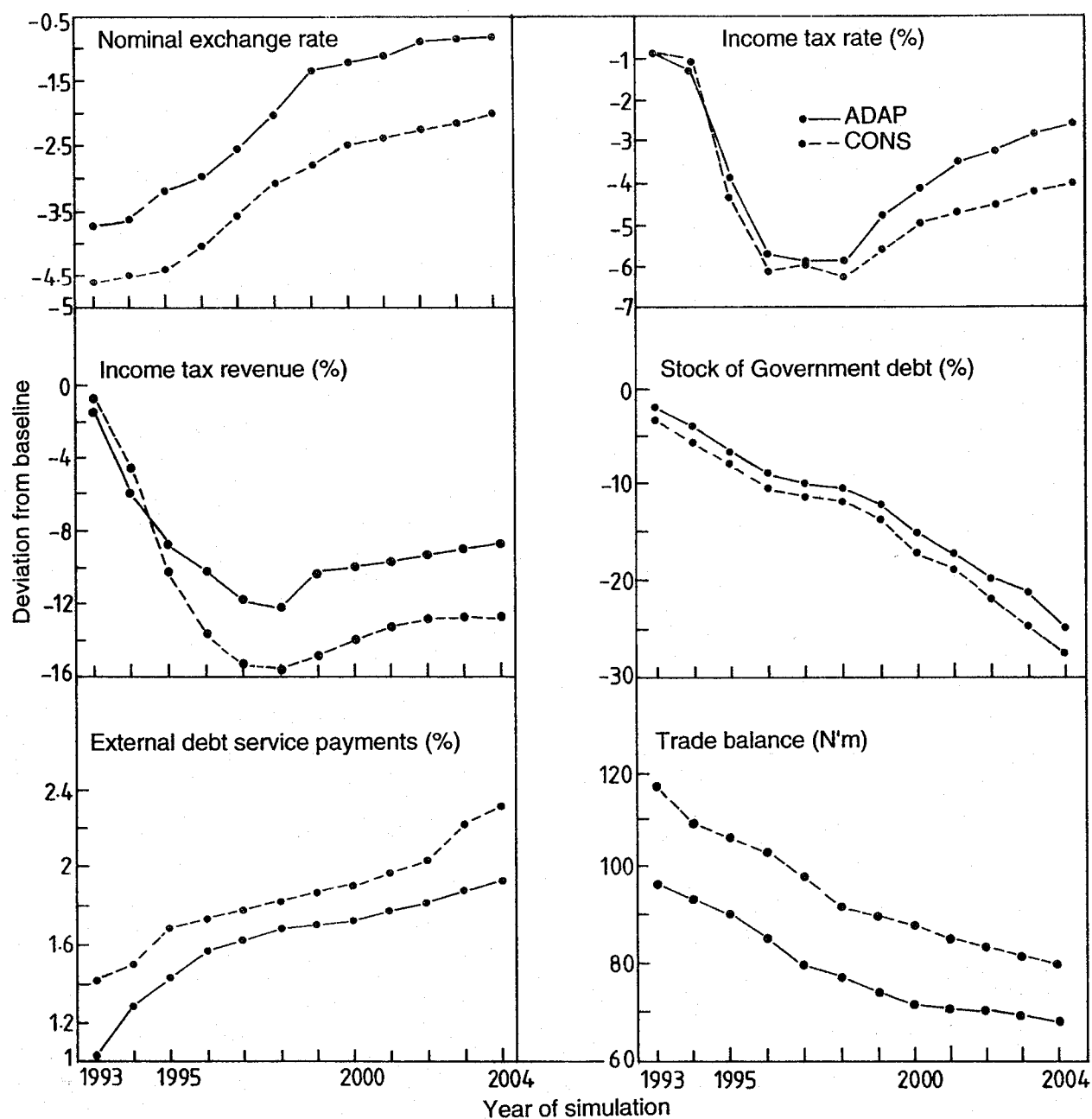
Figure 1-C: Fiscal contraction shock....contd

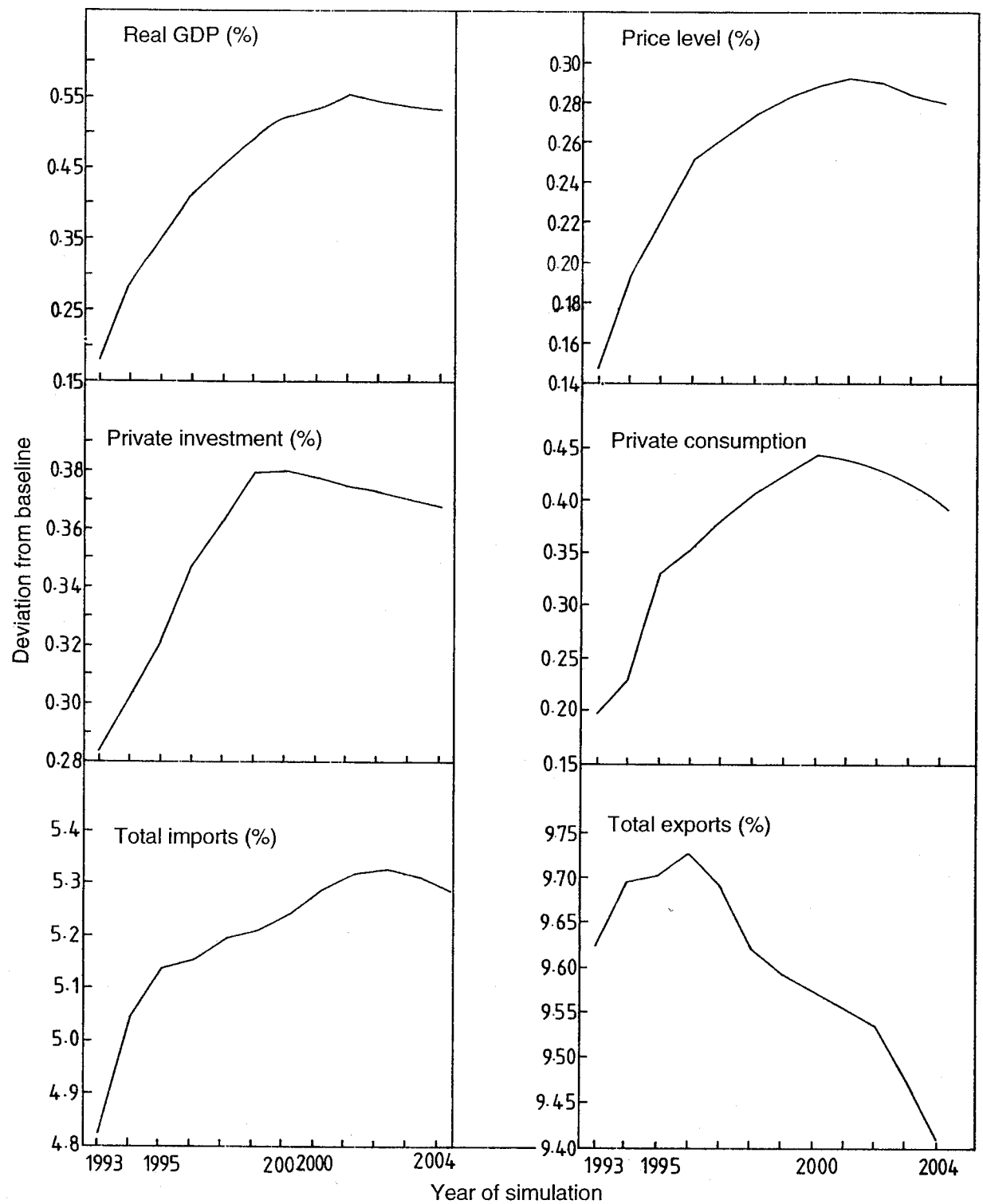**Figure 1-D**: Fiscal contraction shock ....contd

Year of simulation

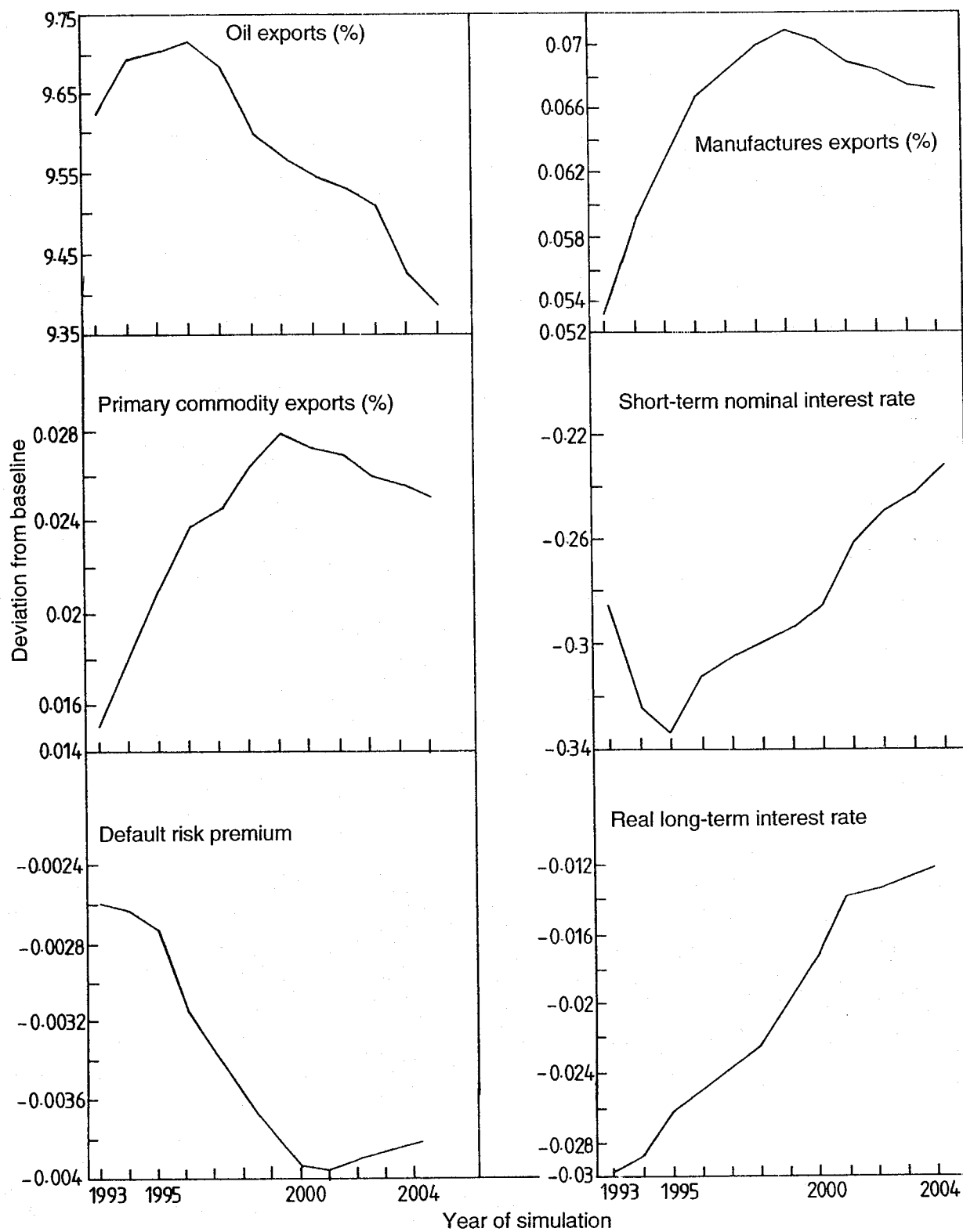**Figure** 2-A: Oil price shock (model-consistent expectations)

Figure 2-B: Oil price shock (model-consistent expectations)....contd

Figure 2-C: Oil price shock (model-consistent expectations)....contd