CEAR

(Centre for Econometric and Allied Research)
UNIVERSITY OF IBADAN, IBADAN
NIGERIA

NPC/UNDP/UNDTCD PROJECT NIR 87/009
PERSPECTIVE PLANNING NIGERIA

A SURVEY OF EXISTING PLANNING MODELS OF THE NIGERIAN ECONOMY

[PROJECT PAPER PP92-002]

BY

A.Adenikinju, A.Jerome, O.Ogunkola, S.Olofin

Jan. 1992

PREFACE

The purpose of these series is to provide hard copy documentation of the series of output that are being generated from CEAR's involvement in this project. Some of these output would aim at documentation of work already done that have hitherto not been fully documented, as well as provide full documentation of work in progress and future work, as they are executed. The project implementation involves collaboration between various institutions viz, the Perspective Planning Unit of the National Planning Commission[1] [PPU/NPC] Lagos, the United Nations Department of Technical Cooperation for Development [UNDTCD], New York; the United Nations Development Programme [UNDP], the Centre for World Food Studies [SOW-VU], Free University, Amsterdam, Netherlands, and the Centre for Econometric and Allied Research [CEAR], University of Ibadan, Ibadan, Nigeria. Consequently, it would be normal to expect, that some of the output to be produced in these series would be the outcome of the joint effort between these collaborating institutions. Where this is the case it will be so stated explicitly. As agreed at the October 1991 meeting of the Project's Implementation Committee [PIC] the final documents or output from the project will be treated and regarded as the joint produce of the collaborating institutions. What is intended in these series, is a means of presenting to our collaborating institutions, results or initial output of work meant to be initiated by or at CEAR, either as final output or as intermediate inputs into the process of working in conjunction with the collaborating institutions towards producing final outputs. These series of papers therefore essentially fall under the category of working papers or technical papers as outputs of the project.

In the present paper [PP-92-02], a comprehensive survey of formal analytical macro models of the Nigerian economy is undertaken. The survey includes both models that may have found some specific applications in policy analysis, and those that have not. The objective of the survey is to provide a documentation of what exist, identify some of their limitations, and provide justification for the kind of modelling work being undertaken within the context of the present project.

Professor S. Olofin

Director, CEAR.

1. The former Federal Ministry of Budget and Planning [FMBP] is likely to be replaced by the National Planning Commission, following from the on-going reorganization of government departments.

TABLE OF CONTENTS

INTRODUCTION.

The planning process partly involves determining social objectives, setting targets, disseminating information, as well as organizing a framework for implementation,coordination and monitoring the implementation process. An integral part of the planning process are planning models. While controversy rages over the role of formal planning, as well as the link between planning and plan implementation, there is widespread acceptance of the usefulness of some form of analysis as a basis for government policy (Chenery, 1982). Planning models, whether qualitative or quantitative serve as useful devices for formulating plans and investigating trade-offs and ensuring consistency. They serve the useful purpose of providing critical information regarding likely alternative time paths for the economy. By using qualitative and quantitative models, the planner is able to systematically analyse different economic relationships that may not otherwise be easily comprehensible. These provide a qualitative basis for the necessary dialogue between the planner and other participants in the planning process.

Generally speaking formal planning models are needed for three main purposes, namely, forecasting, consistency checks and optimization. Economic forecasts are needed when it is necessary to estimate medium or longer term development alternatives. Consistency requirements in a narrow sense are usually viewed in terms of economic or technologically feasible relationships between disaggregated or sectoral breakdowns vis-a-vis national aggregates. Optimization on the other hand involves exploring the choice set of the economy for possible extensions of its efficiency frontier.

More than forty years of empirical experimentation, since the first mathematical planning models were formulated in Hungary between 1957-1958 has brought considerable progress into the field. Considering the complex nature of most economic systems, only sophisticated quantitative modelling can ensure logical and systematic as well as internal consistency in the planning of such economic systems. This has led to the development of various forms and types of planning models over the years. The suitability and adequacy of a particular type of model is often dependent on the use to which it is to be put, the type, structure and characteristics of the economy to be modelled, and the computational feasibility of the model within the context of the economy to be modelled. However, it must be noted that while a model is a reflection of reality no model is a perfect representation of reality. Any model no matter its degree of sophistication can only incorporate certain aspects of the real world. Whatever its limitations might be, the fact that it offers the scope for trying out several experiments and being able to evaluate their likely outcomes ex-ante, offers considerable advantage over rule-of-thumb or informal modelling methods, in which evaluation of several alternatives may either be difficult or impossible ex-ante, (Olofin, et.al., 1988).

It is useful to appreciate the peculiar problems of modelling in the environment of an underdeveloped country. The specific problems which the modeler must tackle are several. First is the usual problem of dualism - the existence of a sizable, traditional sector characterised by informal and largely unquantifiable variables and a modern sector, relatively monetized for which data are more readily available. Second and a corollary of the above, is that the reliability of data available, even in the modern sector is always suspect. The third problem is the irrelevance of much of received economic theory on which the theoretical foundations of economic models are based. Finally, there is a shortage of computational facilities to handle complex functional relationships.

We do have a wide spectrum of planning models available today. They range from sectoral models to economy-wide models. Planning models can also be static or dynamic depending on whether time is incorporated and allowance explicitly made for investment feedbacks. They are increasingly becoming more complex in line with general improvements in the approaches to economic planning and policy making, and the availability of computing facilities.

Since attaining independence in 1960, Nigeria has launched five National Development Plans. This paper aims at a concise non-technical survey of the various models of the Nigerian economy that have been developed over this period, whether they have found direct application in the planning process or not.

2. EXISTING MODELS OF THE NIGERIAN ECONOMY

The history of building formal models of the Nigerian economy can be traced to the pioneering work of Carter in 1960. Then, he constructed an input-output table to assist in the preparation of the nation's First Development Plan, 1962-68. Since then, several modelling efforts have been undertaken. Existing models of the Nigerian economy can be categorised into three broad groups. These are input-output models, the macroeconometric models and the computable general equilibrium models.

2.1 INPUT-OUTPUT MODELS

Input-output modelling owes its development to the pioneering work of Leontief (1941). In a restricted sense, it constitutes a general equilibrium analysis, to the extent that it emphasizes structural interrelationships among productive activities.They have been applied widely in both developed and developing countries. The scope of its applications include, checking for the internal consistency of national accounts data; the analysis of structural interdependence within an economy; estimation of direct and indirect resource requirements in production process and also for economic planning and forecasting. The I-O analysis is based on three major assumptions, (Gerking, 1976). These are, first, that a given economy can be segmented into interrelated finite number of sectors, each of which produces a single homogeneous product. Second, there is fixity of technical coefficients indicating that in production process, there are neither economies of scale nor diseconomies of scale and third, there is a fixed correspondence between level of output and input requirements from all the sectors.

The I-O models constitute the first set of models that were developed for the Nigerian economy. Efforts in this direction include, Carter (1960), Clark (1968), Aboyade (1981), Olayide, et.al (1981), Iyaniwura, et.al (1988,1991), Amachree (1988) and Frausum, et.al. (1989a,1989b).

The pioneering efforts at the construction of an I-O table of the Nigerian economy began with the efforts of Carter in 1960. Utilizing data base derived from both internal (especially the Okigbo's 1950-57 National Income Accounts for Nigeria) and external sources, Carter (1960) generated an I-O table for the NIgerian economy for two years, 1959 and 1960.

The initial efforts of Carter were modified and extended by Clark in 1968. The reference year for his model was 1959. Clark's stated objective was basically to specify an optimal pattern of import substitution for the Nigerian economy.

The next major attempt was undertaken by a team under Aboyade. They constructed an I-O table for the period 1973-75. This was not applied in any particular modelling context. Rather it was prepared as supplementary tables to the tables of Nigeria's system of national accounts.

A major limitation of these three tables was that they could not be up-dated beyond the immediate periods for which they were constructed. However, to enhance their relevance, I-O tables must be capable of being updated regularly to reflect structural shifts in the economy and on the availability of better and more reliable information.

Aboyade's efforts was subsequently extended and updated by Olayide and his team in the then University of Ibadan Forecasting Programme (UIFP) now CEAR. Irked by the stop-gap approach and non-operationalization of previous input-output modelling attempts beyond the immediate use for which they were constructed, Olayide et.al (1981) developed a methodology for annual updating of the input-output tables without recourse to primary data.The table which has 1970 as its reference base derived its technological coefficient from seven year time-trend data covering 1964-70. Amachree (1988), used the RAS method to update the 1973 I-O table constructed by Aboyade to 1985.

The Centre for Econometric and Allied Research (CEAR) of the University of Ibadan under a team led by Iyaniwura, J. have also constructed an input output model, capable of being updated periodically in an attempt at saving costs and efforts involved in preparing new I-O tables from scratch, reduce the speed of obsolescence of models and to provide a handy tool to assist in policy evaluation (Iyaniwura, et al.,1988). Two I-O tables for 1980 and 1984 respectively are presently in place at the centre for this purpose. These are to be updated as soon as Federal Office of Statistics published data become available.

Finally, at the Policy Analysis Department (PAD) of the Federal Ministry of Industry, a team coordinated by Frausum (1989a) prepared a 1984 input-output table for the economy (The NISER-PAD Table). As the team acknowledged the table was more of an attempt at assisting in the preparing of an industrial master plan (in terms of its almost exclusive focus on the manufacturing sector) than an economy-wide input-output table aimed at wider modelling applications. Another one was attempted for the whole economy, more recently, Frausum (1989b).

These various tables while sharing a number of features in common, however differ in terms of level of disaggregation, source of primary data and compilation techniques, and intended modelling applications.

Several factors influence the level of disaggregation of an I-O table. These include the objective of the study, availability and reliability of data used, resource constraints, and the need to keep the table tractable and compact as well as the level of inter sectoral linkages in the economy. These factors have severally and jointly influenced the observed level of disaggregation of past I-O tables. The Carter I-O table consists of 20 sectors made up of 5 agricultural sectors, 10 manufacturing sectors, and 5 service related sectors. The sectors identified included Agriculture, Livestock, fisheries, Forestry, Agricultural Processing, Textiles, Apparel, Drinks and Tobacco, Food, Metal, Mining, Non-metal Mining, Chemicals, Transport, Utilities, Trade, Construction, Construction, Services, Transport Equipment, Non-metallic, Wood/leather/paper and Miscellaneous. In spite of this high level of aggregation there was still a low level of inter-sectoral linkage as represented by the proportion of empty cells in the matrix. The Transport, Service and Trade sectors in that order were the most significant in terms of linkages with the rest of the economy. On the other hand, Food, Metal mining, Textiles and Clothing have the weakest especially forward linkages with the other sectors.

Using Carter's table as a basis, Clark embarked on a massive effort involving a highly disaggregated 86x86 table made up of 25 actual producing sectors, describing the structure of the Nigerian economy for the year, 1959 and additional 61 new "potential sectors" representing competitive imports were added to the original matrix to produce a massive 86*86 matrix.

Aboyade's I-O table consists of 25 sectors. The increasing importance of the oil sector in the Nigerian economy also guaranteed it a distinct treatment in the sectoral disaggregation. Subsequent I-O tables follow this lead of separate treatment of the oil sector in their modelling. These sectors included Agriculture, Livestock, Forestry, Fishing, Oil Mining, Other mining and Quarrying, Food, Drink, Textiles, Wood, Paper and Paper products, Drugs and Chemicals, Rubber and Plastic, Basic Metal, Fabricated metal, Electricity and Water, Building and Construction, Transport, Communication. Housing, Finance and Insurance, Professional Business, Hotel and Catering, Producer of Government services, and Distributive Trade. Again in Aboyade's table, Transport, Distributive Trade, and Electricity and Water recorded the highest level of inter-sectoral especially forward linkages.

Another feature common to these first three tables are the similarities in the technological coefficients obtained for uniformly defined sectors. For example, the figure under column one, row one in Clark's table is identical with the comparable figure of 0.0489 in column one, row one of Aboyade's table. However it is not uncommon for I-O compilers to borrow coefficients from other tables.

Amachree's tables consist of 50 sectors disaggregated from the initial 25 sectors by Aboyade. The UIFP (CEAR) tables were of two versions, the 52 sector tables and their more aggregated 25 sector tables designed for different modelling applications. The first UIFP (CEAR) table documented in Olayide, et.al.(op.cit.) consists of 50 sectors including 3 subsectors for Mining and Quarrying, 4 subsectors for Agriculture, while the manufacturing sector was subdivided into 36 subsectors. Other sectors included in the table are, Electricity, Water, Building and construction, Distribution, Transport, Communication, and Miscellaneous. However, at the time of its construction, many of the cells were empty due to the unavoidable problems of paucity of data and high degree of unreliability of available data.

The PAD tables were of two versions, the initial 21x36 input-output table of the manufacturing sector which was to be used " to assess impact intensity, measure the effective rates of protection and compute domestic resource cost " of industrial policy on the aggregate economy, consist of 21 manufacturing sectors and 15 non-manufacturing sectors. There are two major problems associated with this table, first, because of its being rectangular, the inverted matrix cannot be obtained and secondly, since the manufacturing sector is but one of the sectors of the economy the technical coefficients so obtained is a partial one and would most likely differ from one for the aggregate economy. The authors tried to correct for this limitations in the second version by constructing an economy-wide input-output table of 20 sectors.

These various tables also vary from one another regarding the sources of primary data and estimation techniques. The first two tables by Carter and Clark relied both on Nigerian and non-Nigerian data sources to fill some cells. Clark's table in particular relied on the data from other developing countries to derive parameter estimates for the model that was based on his table. The table in turn borrowed several technological coefficients from other developing countries. This lack of comparability in data sources to our mind constitutes one of the most serious limitations in reconciling these tables with one another, and in interpreting the results of modelling applications based on the tables. In addition, since Carter's table was prepared for 1959, a major proportion of his estimations had to be based on extrapolations of trends and ratio projections. Also, Clark's massive 86x86 table was not an empirical matrix wholly based on Nigeria's empirical data. Rather it was derived as a by-product, of an attempt at specifying a potential technology for promoting planned import substitution (Olayide,et.al. 1981 p.3).

Aboyade's table derives from Nigerian data secondary and primary origins including special surveys such as the rural economic surveys. Olayide, et al. and Amachree updated Aboyade's effort. The former used new primary data of Industrial survey of the FOS. Also it used 1970 as its base and instead of basing the estimates on the data of that year, the authors departed from the conventional practice by filling their matrix of transaction flows with 7 year average of time series covering 1964-1970. In other words, the parameters used were not the actual ones derived from the structure of the economy in 1970. Most CEAR's tables for 1980 and 1984 were based mainly on Industrial Survey and other data of the Federal Office of Statistics (FOS) and the Central Bank of Nigeria (CBN) and supplemented with other international sources such as the IMF's International Financial Statistics, World Bank's Debt Tables, etc, while PAD also relied on domestic information especially the industrial census survey of the FOS for 1984, supplemented with national accounts data.

It is necessary to reiterate that all these tables and their modelling applications suffer from the weak primary data base existing in the country. Thus the modelers have to grapple with the twin problems of non-availability and/or inconsistencies in the data base.

The existing I-O tables were constructed with different objectives in view and this has been reflected in the structures of the tables. The Carter's table was developed for use in preparation of the nation's First Development Plan, 1962-68. Clark's table was part of a doctoral dissertation project at Massachusetts Institute of Technology (MIT), aimed at specifying an optimal pattern of import substitution for the Nigerian economy. Aboyade's table was multi-purposed. Its objectives included the preparation of national account statistics and scenarios of policy simulations by those who may wish to make use of such applications. The UIFP and Amachree tables were extensions and updates of Aboyade's tables. Particularly, the authors of the former table were anxious to demonstrate that an operational I-O table for the Nigerian economy can be constructed using on secondary data as sources. The CEAR models have additional objectives of not only the operationalizing the construction of I-O tables but also assisting in providing a model for carrying out consistency checks of policy decisions. In fact, the 1980 I-O table was linked with the Klein type macroeconometric model to operationalize a multi-sectoral consistency planning model (MS-CPM) for economic policy analysis in Nigeria (Olofin, et. el. 1988). Finally, the NISER-PAD table essentially focussed attention on policy studies relating to the manufacturing sectors of the Nigerian economy.

The major limitations of the I-O based models for economic analyses and projections are well-known. These include the assumptions of fixed input output coefficients which are not responsive to relative price changes even in the long run, the neglect or impartial treatment of the household sector's behaviour, the possibility of flip-flop behaviour and the fact that existing distortions such as taxes, subsidies in the economy can not be incorporated into the models. Some of these limitations are rectified when I-O models are upgraded to Activity Analysis intersectoral models, or better still into Applied General Equilibrium models where feedback mechanism for final demand is explicitly allowed for using some optimization rule.

While the most recently developed version of CEAR's I-O based General Equilibrium model intended for consistency checks in the preparation of the First National Perspective Plan, does not explicitly allow for Activity Analysis type of technology variations, it incorporates some elements of final demand feed back specification in relation to savings and investment decisions, without any allowance for optimization considerations. Such extensions are envisaged in future work.

2.2 MACROECONOMETRIC MODELS

Macroeconometric models have some distinguishing features. These include the identification of exogenous and endogenous variables, a sufficient time or cross sectional data series and non-deterministic model specifications. Models of this type gained preeminence mainly in the 1970s and 80s and their applications range from sectoral to national, regional and even global studies as typified by the UN based LINK projects and other global modelling work.

Several attempts at building a macroeconometric model for the Nigerian economy has been made in the past. These range from individual efforts, to institutionally supported ventures. The objectives behind their construction have also varied from purely academic exercise, to practical policy applications. In the former category are the models by Ojo (1972), Adamson (1974), Gosh and Kozi (1978), Olofin (1977) and Uwujaren (1977). Those models with institutional bases are those by World Bank (1974), UNCTAD (1973) and the models by NISER (1983,1987). Others include, CEAR-FMNP-MODEL, MAC 111, CEAR-MODEL-MAC 1V and the CEAR LINK model. All these models except for the CEAR models suffer from lack of regular updating or revisions. In addition, only the last set of CEAR models coupled with Ojo, Uwujaren, World Bank and NISER '87 models have been simulated for numerical solutions. While we would not go into a detailed descriptions of each model, we would highlight some of their key and common features, the most important being their demand side emphasis and neglect of micro considerations. We begin by discussing briefly Ojo's model.

2.2.1 Ojo's Model

The Ojo model was part of the author's doctoral research effort at the University of Iowa. The model was intended as a medium term planning model for the Nigerian economy.

The model disaggregated the Nigerian economy into three key sectors, the foreign trade, public and agricultural sectors. The model consists of fifteen equations out of which nine are stochastics while the remaining six are identities and definitions. The model consists of seventeen exogenous variables and is essentially a convectional Keynesian demand driven model.

Consumption was disaggregated into agricultural and non-agricultural consumption, and in each case a function of disposal income, specified as,

$C_t = f(Y^d_p)$

where

C_t= consumption at time period t; and

Y^d_p= permanent or expected disposable income

A quasi-acceleration specification was employed for the investment function making investment a function of expected level of income:

$I_t=F(Y^e_t)$

I_t is investment demand at time t while Y^e_t is expected level of income at time t.

On the supply side, the supply of agricultural commodities was made a function of one period lagged agricultural commodity prices and the level of income. The specification was of the form,

$Y^A_t=f(Y_{t-1},P^A_{t-1})$

where

Y^A_t= output in agriculture at time t

Y_{t-1}= income lagged one period and

P^A_{t-1}= agricultural prices lagged one period.

In the specification of the foreign trade sector equations, import demand was made to depend on expected value of GDP, and price of imports relative to domestic prices. The export equation was a function of an index of the volume of world trade, as a proxy for world economic activity as well as export price expressed as a ratio of domestic prices. There are also equations for direct and indirect tax revenues.

Given the relatively small size of the model, it was solved using 2SLS method of estimation based on time series data spanning 1951-1965, a period of sixteen years. An iterative solution process was employed to simulate the model and carry out some multiplier analysis.

The model however had some major limitations. First, no explicit production function was specified nor price formation relationships allowed for, due to its rudimentary nature at the time the model was constructed, while the external sector was not rigorously specified.

2.2.2 The World Bank Model.

The World Bank Model was part of a general perspective study of the Nigerian economy by a World Bank Mission, (World Bank, 1974). The model was constructed to provide an analytical framework for the analyses of the pattern and implications of expected developments in the Nigerian economy over a fifteen year time horizon.

This was in effect an attempt to formulate a Perspective Plan for Nigerian based on what was intended to be a long term or perspective planning model. There are significant differences between what was envisaged in this initiative and the on-going effort to prepare the country's first Perspective Plan. First this was a purely limited study conducted at the initiative of the World Bank as part of an advisory mission, with little or no inputs whatsoever from the host country nor any obligatory requirements that the resulting document be adopted for implementation purposes. Consequently, its status for implementation purposes never went beyond that of an in-house working document of the initiating institution, even though it was eventually published.

Secondly it was very limited in scope and content, and was hardly aimed at addressing any particular policy issues, other than providing some qualitative gaze into a plausible future time path of growth, using highly aggregative economic indicators such as overall GDP growth rate. Thirdly, the model on which these forecast were based was a simple prototype model based on specifications, parameters, and cross sectional data of several developing countries, as opposed to country specific specifications and data for estimating model parameters. Fourthly, not only was the model employed highly rudimentary, it hardly could have benefitted from the later flowering of Computable or Applied General Equilibrium approach to modelling for perspective planning.

The model was basically Keynesian or demand driven, as the overall growth of the economy was assumed to be generated by the response of other sectors to the demand for consumer and intermediate goods, generated in the model. The income and inter-industry multiplier effects were assumed to derive from the interactions of the sectors with each other and with the household and public sectors, (World Bank, p.111). Increased demand in each sector was assumed to stimulate investment expenditure, which in turn generated increased output. Time lags were introduced between demand generation, and the resulting investment expenditure, and between investment expenditure and actual production. The pre-specified developments in the agricultural and petroleum sectors however provided the exogenous stimuli that drove the model.

A major interesting feature of the production relations in the model was that intermediate demands were related to production activities by use of input-output coefficients. Subsequent CEAR macroeconomic models have retained this feature.

All variables in the model were defined in both constant base-year prices and in current prices, except financial variables which were defined only in nominal terms. The model was specified as a two-gap model with independent specifications of the investment, savings functions on the one hand, and the export and import functions on the other hand.

The World Bank model could hardly be described as a conventional econometric model in the sense of having a system of equations specified, with the parameters estimated from time series data. Rather fixed coefficients on which there was little or no explanation as to how they were obtained (most probably borrowed from other countries) were employed, along with the initial value of the endogenous variables and time series of exogenous variables to carry out a simulation of the model, over a fifteen year period, 1970-84.

There were in all about 107 relations, most of which were definitional, even though it is difficult to classify the relation under the traditional heading of stochastic or behavioural equations and non-behavioural equations. There was very little evidence to suggest that the model's parameters were estimated from a time series data based on the Nigerian economy, or that the parameters were subjected to any of the usual standard statistical tests.

There is no evidence to show that the model was ever operationalized neither is there any evidence to show that it has been employed within contexts other than for which it was specifically designed. Being more of a prototye model with parameters that most probably had very little to do with the detailed characteristics of the economy being modelled, and due largely to the model builders self-acknowledged limited knowledge of the Nigerian economy, the model has very limited potential for continuous updating for application purposes. It was a model constructed with some particular context in view - that of a general perspective study, and it was considered adequate for this purpose.

2.2.3 Uwujaren Model

Like Ojo's model, this was also intended to be part of the author's doctoral dissertation presented to Colombia University in 1977, (Uwujaren,1977). The model disaggregated the economy into four sectors viz, primary or agricultural sector, secondary or manufacturing sector, tertiary or services sector and a separate sector for mining and petroleum, to take care of its growing importance in the economy. It sought to incorporate both demand and supply side considerations, and in the author's evaluation the model is essentially supply determined; (Uwujaren,1977:108). It is not strictly speaking a general equilibrium model, but is closed by the imposition of an equilibrating condition which works through inventory decummulation or accumulation, to take care of negative or positive aggregate excess supply in relation to aggregate demand.

The model consists of 62 equations including 33 behavioural equations and 29 identities and definitions as well as having 33 exogenous variables. A Harrod-type capital-requirement functions for the four sectors is specified as follows:

$$Y^i_t = a_o + a_1 K^i_{t-1} + u_i$$

where Y_i is the output of sector i and K^i is capital stock in sector i and u_i, the error term.

For the consumption function he employed a variation of the permanent income hypothesis with,

$$C_t = f(Y_p)_t$$

where C_t is consumption at time t, and $(Y_p)_t$ stands for permanent income at time t.

Another key equation, which explains the level of government income makes government income a function of population (POP_t) and government revenue (GR_t):

$$G_t = \quad + \beta_1 GR_t + \beta_2 POP_t + u_t$$

As for investment functions, a flexible accelerator type of investment function was specified for each of the three modern sectors, viz, manufacturing, mining and services.

The model also specified a rudimentary financial sector in which desired demand for real balances is specified as a function of real income and expected inflation rate as a proxy for cost of holding real balances. Money supply is endogenized and determined by a multiplier process in which the monetary base is taken as the sum of net domestic and foreign assets of the monetary authorities. The external sector of the model is also fairly more developed than the previous two models. In the foreign sector there are four import demand equations, disaggregated into consumer non-durables, intermediate goods and raw material imports, as well as demand for capital goods. Export demand equations are specified for non-oil exports, and an export supply function is estimated for the oil sector.

The model was estimated on annual (1953-73) data, using an instrumental variables method. There is no current evidence that there is any on-going effort to regularly update the model and subject it to applications on a continuing basis.

2.2.4 CEAR Models

The two documented CEAR models CEAR-FMNP-MODEL-MAC III (Olofin and Ekeoku,1984$_b$) and the CEAR-MODEL-MAC IV (Olofin and Poloamina, 1984) shared a lot of features in common, including a common origin. In fact, the latter was a more disaggregated version of the former model. Since the models are meant to be operational they have since undergone several processes of revisions, modification and updating. These revisions are to ensure that the models become continually relevant to keep track of the workings of the economy and hence to be relevant for policy decisions and evaluation.

The models have a common origin in an earlier model, (Olofin 1977) which was estimated but never simulated. The latter model was subsequently expanded into a University of Ibadan Forecasting Programme, UIFP-model 1 (Olayide, et. al. 1980) which consists of 120 equations of which 62 were stochastic. The problem experienced with the simulation of this model gave rise to a new version, UIFP-model II (Olayide, et al. 1981). It was made up of 55 equations of which 47 were stochastic. Problems with its simulation soon gave rise to another model UIFP-model III (Olayide et al.1981$_b$) which can be safely regarded as CEAR first successful attempt at having an operational model. This model therefore became the percussor for the CEAR-FMNP-MODEL-MAC III model. Its initial substantive revisions and application were documented in (Olofin and Iyaniwura, 1983; Olofin and Ekeoku, 1984$_b$). Its last published version consists of 97 equations of which 43 are stochastic and 28 pre-determined variables. A latter major revision of the model involved the incorporation of a capital flow sector, as mounting external debts assumed greater significance in influencing the level of economic activity.

The original version of the CEAR MAC IV model was first developed in 1983 in the form documented in (Olofin, et. al., 1983a). This was later refined and simulated and documented in (Olofin, et al., 1983$_b$). In a version of the MAC IV a total of 176 equations of which 89 were stochastic was estimated and solved and reported in Adeniyi et al., (1983). This version has also recently been revised to incorporate a capital flow sector, in what is being documented as CEAR MODEL

MAC V, (Raheem, Ogunkola and Olofin, 1991).

This process of revisions would have to continue, for as long as there are changes in the Nigerian Economy warranting changes in model structure, or changes in the assumptions on which model specification is based. The centre also continues to maintain an unpublished version of its econometric models for twice a year simulations of Global Economic Prospects as part of a global network of United Nation/University of Pennsylvania/University of Toronto supported Project LINK.

2.2.5 Models Without Solutions

The two models UNCTAD (1973) and NISER (1983),were not formally solved. The UNCTAD model consisted of five sectors, viz, Agriculture, Mining, Manufacturing, Government services and Non-government services. It also consisted of 37 equations, out of which 20 were stochastic. The model also distinguished between two categories of investment demand, one for private investment in the petroleum sector, while other, private investment demand, that is excluding petroleum is made a function of total monetary value added in all sectors and cummulative government investment expenditure. In the external sector, import functions were estimated for four commodity groups, foodstuffs, raw materials, manufacturing goods and petroleum products. Exports were divided into mining and agricultural exports. A number of government sector functions were then included to close the model. The model was estimated using OLS technique with annual data covering the period 1955-1966.

The original NISER model consisted of 71 equations out of which 47 were stochastic. It was divided into seven blocks, consisting of production, balance of payments, demand, foreign trade, employment, price and money, (NISER, 1983). The OLS method was employed in estimating the model on annual data.

However, it is useful to point out that a latter version of the NISER Econometric Model Version 1987 was developed as an operational model for short-term planning and for policy analysis. The model has been employed by researchers based in PAD to evaluate the Nigerian monetary policy under the structural adjustment programme. The current version comprises 80 equations of which 50 are stochastic. There are six blocks- production, aggregate demand, government, employment, money and prices. The model also attempts to link the money and price blocks with the production and aggregate demand blocks through adjustment in relative prices, domestic credit and interest rates. Several simulation runs have been performed using the present version.

2.3 COMPUTABLE GENERAL EQUILIBRIUM MODELS.

One major limitation of the Leontief input-output model is the exogeniety of technology and final demand. The fixity of I-O coefficients that are unresponsive to relative price changes make substitution possibilities between factor services impossible. Thus it is not possible to switch from one production combination to another in response to policy changes like subsidy removal on particular factor inputs e.g. energy input.

Computable General Equilibrium (CGE) models try to relax this assumption. Through various production functions such as Constant Elasticity of Substitution, CES, Cobb-Douglas production function and the Transcendental Logarithmic function, explicit substitution elasticities are stated. The Translog function is the most flexible among all these functions as it places no a'priori constraints on the elasticity parameters. The choice of functional forms however have implications on model results (Adenikinju, 1991).

The treatment of final demand in I-O model does not allow for the feedback relationship between production process, factor income, relative prices and final demand. These limitations therefore make the incorporation of price incentive variables that represent the essential tool to planners and policy makers for influencing economic relationship very difficult. Input-output analysis may be useful to the extent that they allow for consistency checks of policy decisions.

The macroeconometric models also have their own limitations. They suffer from weak microeconomic foundations. In addition, they depend not only on consistent time series data which is a luxury in most developing countries, including Nigeria, their construction is also often influenced by the modeler's particular perception of the workings of an economy. For instance, the modeler determines which variables to consider endogenous and which to exogenise. Distributional considerations in evaluating effectiveness of policy or policy changes are often neglected or partially considered.

Though, CGE models are still fairly recent they represent important improvements on the I-O and macroeconometric models. The CGE models seek to provide the microfoundations for macroeconomic analyses. They conceptualize the economic process in terms of optimality behaviours and decisions of individual agents in the economy. Although, primarily neo-classical, CGE models are flexible enough to incorporate structural features commonly found in developing countries such as wage rigidities, and price distortions like tariffs and subsidies.

Until the pioneering work of Johansen (1960), general equilibrium modelling remained simply an abstract theoretical exercise without relevance to policy analysis in real world economies. Since Johansen's earlier attempt coupled with rapid advances in computer algorithms, there have been several applications of these models in developing and developed countries covering all areas of economic analyses such as finance, income distribution and growth, energy issues, macroeconomic adjustments, just to name a few policy application areas. Computable General Equilibrium models are even more relevant today for developing countries considering the global trends towards market economy and the substitution of price signals for quantity signals in resource allocation.

Prior to the on-going efforts at CEAR to apply an I-O general equilibrium model for consistency checks in the preparation of the country's first Perspective Plan (Olofin et al.,1991), there had been an attempt by Taylor, Yurukoglu and Chaudhry, 1983 and more recently by PAD under the direction of Stewart, to apply CGE modelling to analysis in the Nigerian context. The underlying theoretical paradigms

Though, CGE models are still fairly recent they represent important improvements on the I-O and macroeconometric models. The CGE models seek to provide the microfoundations for macroeconomic analyses. They conceptualize the economic process in terms of optimality behaviours and decisions of individual agents in the economy. Although, primarily neo-classical, CGE models are flexible enough to incorporate structural features commonly found in developing countries such as wage rigidities, and price distortions like tariffs and subsidies.

Until the pioneering work of Johansen (1960), general equilibrium modelling remained simply an abstract theoretical exercise without relevance to policy analysis in real world economies. Since Johansen's earlier attempt coupled with rapid advances in computer algorithms, there have been several applications of these models in developing and developed countries covering all areas of economic analyses such as finance, income distribution and growth, energy issues, macroeconomic adjustments, just to name a few policy application areas. Computable General Equilibrium models are even more relevant today for developing countries considering the global trends towards market economy and the substitution of price signals for quantity signals in resource allocation.

Prior to the on-going efforts at CEAR to apply an I-O general equilibrium model for consistency checks in the preparation of the country's first Perspective Plan (Olofin et al.,1991), there had been an attempt by Taylor, Yurukoglu and Chaudhry, 1983 and more recently by PAD under the direction of Stewart, to apply CGE modelling to analysis in the Nigerian context. The underlying theoretical paradigms in the two approaches diverge significantly one from the other. While the model by Taylor, et. al. was essentially structuralist in approach combining the features of neoclassical and Keynesian economics, the latter work by PAD was strictly neoclassical more or less being a replication of the model by Dervis, de Melo and Robinson (1982), although, the authors claimed that the model was adapted to and run under a variety of assumptions specifically relating to the local Nigerian macroeconomic environment.

The latest version of the PAD model, which is not published but reported in an internal working paper of PAD (PAD, 1988), disaggregated the economy into six sectors: agriculture, oil and gas, two manufacturing sectors (consumer non-durable, intermediate goods and consumer durable), infrastructures including utilities, construction and transport and services. The model is said to have 144 equations and 144 endogenous variables . The exchange rate is chosen as the numeraire by which other relative prices are determined. A SAM built around 1985 data is said to provided a benchmark data base for counterfactual analysis and parameter estimates. The model is claimed to have both dynamic and static versions. In the dynamic version, investment which takes place in period t adds to the capital stock in period (t+1) and the capital stock grows annually by an amount equal to net investment. In addition, exogenously determined growth paths are said to be specified for variables such as labour supply, technical progress in production, government consumption and import and export prices. However, the dynamic solution path is claimed to be achieved as a series of static optimization processes and not as a full intertemporal optimization process, implying that expectations are certain.

In line with most conventional CGE models, the PAD model neglects the financial sector of the economy. This conforms to the theoretical Walrasian model where only relative prices matter in the long run. A major limitation of this model is its poor data base and rather casual if not unrealistic assumptions about the structure and workings of the economy. The model was also strictly neoclassical in conception neglecting the structural rigidities of the economy, and too aggregative to permit detailed analysis of government policies. For instance, the agricultural sector was aggregated into a single sector. Perhaps what can be considered as another major shortcoming of the model was the non consideration of the income distribution effects of policy changes. While CGE models are expected to consider the efficiency and equity aspects of policy changes, the treatment of the latter has been very poor in most CGE models. Undoubtedly, this has important implications on model results, and applications.

A World Bank team led by Taylor constructed a CGE model to study the adjustment responses of the Nigerian economy to balance-of-payments difficulties that arose in 1983 (Taylor, et al., 1983). The structure of the model reflects both neoclassical and Keynesian features. The model was disaggregated into four sectors, Petroleum extraction, agriculture, manufacturing and 'home goods' (to represent the rest of the economy). The specific rigidities allowed for in the model include, mark-up pricing in the manufacturing sector, wage indexation and price rigidity. The model also makes a distinction between technology in the agricultural and non agricultural sectors. The implication of this on the distribution of value-added in the agricultural sector is that the Euler's theorem no longer holds. The accounting discrepancy arising from this is resolved by attributing the value of output net of intermediate input costs in household income.

Unlike, the PAD model, the Taylor et.al. model tries to integrate both the real and financial sectors of the economy, although the methodology for integrating the two sectors of the economy remain rather weak. The model is also dynamic in a recursive sense. The sources of dynamisation are wage indexation, with money wage increasing in response to increases in cost of living; output in manufacturing sector is not strictly capital limited, but also linked with growth in production capacity. The model was solved on an Apple microcomputer and according to the authors, it might be the "first CGE model running on such a small machine". The summary of their results is that a sector by sector policy intervention to improve economic performance may be better than economy-wide changes such as devaluation, for example, because the changes in relative prices and in income distribution required for real exchange depreciation may prove to be infeasible.

The major criticism against the Taylor, et.al. model may have to do with data sources and parametization technique (see for example, Pesaran, 1986). The authors claimed to have derived their parameter values based "upon knowledge about the Nigerian economy and other countries" and also on "expert opinion". They failed however to disclose how these qualitative factors were converted into quantitative numbers in the model, nor do they carry out sensitivity analysis to determine how the model would perform when the parameters are altered.

Again the treatment of the income distribution effects of policy changes are rather weak. This is reflected in the specification of the demand side of the model where households are aggregated into a single consumer group making analysis of relative income effects of policy shifts impossible.

The I-O based General Equilibrium model, designed for the specific purpose of consistency checks in preparation of Nigerian's first Perspective Planning is fully described in Olofin, et.al. (1991). This model shares in common with the earlier two models, most of the weak features and limitations discussed above.

Apart from the limitations discussed above, the CEAR consistency model, was developed under financial and time constraints under which the development of a full-fledged Applied General Equilibrium model was not feasible. The effort was aimed at developing a simple framework for consistency checks within the time limit and financial resources available for modelling work in relation to the preparation of the first Perspective Plan.

As more resources become available, and the limiting time constraints become more relaxed as envisaged in UNDTCD supported technical assistance programme to fund a CEAR study in collaboration with Centre for World Food Studies (SOW) at the Free University of Amsterdam, a comprehensive modelling effort will address some of these limitations in seeking to develop a stronger data base for a full fledged Applied General Equilibrium or Empirical General Equilibrium modelling, as basis for perspective planning and policy analysis for the country.

2.4. OTHER MODELS

It would not be entirely true to claim that the above review is exhaustive of all models on the Nigerian economy. There are the possibilities of some unpublished work mainly for academic or internal application purposes which might not have been covered in this reviewed.

However, also worthy of mention are two models which are not included in this review. The first is what is claimed to be on-going System Dynamics Modelling project at PAD, (Owosekun and Cleron, 1990). The first phase of the project was said to have been devoted to the construction of a Systems model capable of simulating global macroeconomic issues and to answering general macro-policy questions rather than sectoral issues. The model essentially Keynesian in structure is said to consists of 50 equations and excludes the monetary sector of the economy.

Sobodu (1990) also developed a goal programming based models for planning the Nigerian economy as part of his doctoral dissertation submitted to the Department of Economics, University of Ibadan, Nigeria.

3. CONCLUSION

Modelling has come to stay in the analysis of policy decisions in most countries, in spite of their current limitations. This is partly because they offer the policy maker a logical and rigorous analytical tool rather than the back-of-the-envelope calculations or reliance on hunches for making decisions in an increasingly complex and interdependent world.

In the course of this non-technical review of the existing models of the Nigerian economy, we have been able to identify three major categories to which they can be classified, viz, the I-O models, the macroeconometric models and the CGE models. The earliest efforts were directed at I-O models, followed by the macroeconometric models (though, it must be conceded that there are considerable overlaps between the two). More recently attention has turned to computable general equilibrium models.

CGE modelling in developing countries demands considerable effort due to its extensive data and computing requirements both of which are luxuries in these countries. It however possesses numerous advantages over the other model types. It is particularly more relevant this time in the nation's development effort in which conscientious modernisation effort seeks to emphasis the role of market forces. Its detailed representation of the workings of a market economy including the incorporation of the existing distortions, offer a convenient laboratory for evaluating the impact of policy alternatives in the pursuit of growth, efficiency, and equity in the distribution of income, as means of achieving sustainable longer term welfare gains in a competitive modern market economy that must be equipped to cope with demands of the 21st Century.

BIBLIOGRAPHY

Aboyade, O. et.al. (1991), "The National Accounts of Nigeria: 1973-1975", Federal Ministry of National Planning, Lagos.

Adamson, Y.K., (1974), A Linear Short-time Forecasting Model for National Economic Planning in Nigeria. An Unpublished M.Sc. Dissertation, Birmingham University, U.K.

Adeniyi, J.S., Olayide, N. Ekeoku, S.Olofin, J.Iyaniwura, D. Poloamina, (1983). The CEAR Macroeconomic Model of the Nigerian Economy, Cenre for Econometric and Allied Research, University of Ibadan, DP-83-06; Presented at the Fall Meetings of Project LINK, Tsukuba University, Tokyo, Japen, Sept. 12-16, 1983

Adenikinju, F.A. (1991), "On the Choice of Functional Forms for a Computable General Equilibruim Analusis : A Survey of CGE Models, Paper Presented at CEAR Seminar Series Feb.

Amachree, S.M.O. (1988), Imput-output Tables for Selected Developing Economies. Spectrum Books LTD, Ibadan, Owerri, Kaduna.

Carter, N. (1966), "An Input-output Analysis of the Nigerian Economy 1959-1960" in Srolper W. Planning Without Facts Harvard University Press, Cambridge, Mass

Clark, P.B. (1968), "Choice of Optimal Substitution Patterns for Nigeria" Doctoral Dissertation, M.I.I., Combridge Maa.

Frausum Van, T.G., et. al, (1989), Input-output Table of the Manufacturing Sector, Policy Analysis Department, FMI

----------, (1989b), Input-output Table of Nigerian Economy, Policy Department, FMI.

Gosh D. and U. Kozi, (1978) A Macroeconomic Model for Nigeria, 1955-1974, Empirical Economics. 3(3).

Gerking, S.D. (1976), "Input-output as a Simple Econometric Model" <u>Review of Economics and Statistics</u>, 5-8 (3).

Iyaniwura, J., and S.O. Olofin, (1988), <u>Input-output Tables for the Nigerian Economy</u> (Ibadan: University of Ibadan Press).

Iyaniwura, J.O., and O. Ogunkola, (1992), <u>1984 Input-output Table for the Nigerian Economy</u>

N.I.S.E.R., (1983) The NISER Econometric Model of the Nigeria Economy, Nigerian Institute for Social and Economic Research, Ibadan (MIMEO).

----------, (1987), The The NISER Econometric Model of the Nigeria Economy, Nigerian Institute for Social and Economic Researcg, Ibadan (MIMEO)

Ojo, G. I.O. (1972) An Econometric Simulation Model of the Nigerian Economy. Unpublished Ph.D. Thesis. State University of Science and Technology, Ames, Iowa.

----------, (1973) "A Medium-term Planning Model of the Nigerian Economy", The Nigerian Journal of Economic and Social Studies, 15(1)

Okigbo, P.N.C. (1962), Nigerian National Account 1950-57, Enugu.

Olayide, S.O., S.O. Olofin, J.O. Iyaniwura and J.O. Adeniyi, (1981), An Input-output Model of The Nigerian Economy, (Ibadan University of Ibadan Press)

Olayide, S., S. Olofin and J. Iyaniwura (1985), "Modelling with Limited Facts and Figures", in S.O. Olofin (ed.) Modelling Nigeria Economy Development (Ibadan : University of Ibadan Press)

Olayide, S., S. Olofin, and J. Iyaniwura, (1980), "Large-scale Econometric Modelling of a Dual Economy with Limited Information", Paper Presented at the Ford Foundation Conference on Empirically Oriented Macro-economic Research, University of Western Ontario, Ontario, Canada.

Olofin, S.O. (1985), " A Survey of Past Present Nigerian Econometric Model in S.O. Olofin (ed) Modelling Nigerian Economic Development (Ibadan : University of Ibadan Press)

Olofin, et al. (1988) " A Multi-sectoral Consistency Planning Model (MS-CPM) for Economic Policy Dialogue", Document Submitted to The Nigerian Institute of Social and Economic Research (NISER)

----------, J. Iyaniwura, (1981a), "Appraisal of Large Scale Econometric Modelling of Dual Economies : Nigeria as a Case Study". Centre for Econometric and Allied Research, University of Ibadan, Ibadan, DP-82-01

----------, J. Iyaniwura, and J. Adeniyi, (1981b), "UIFP Econometric Models of the Nigerian Economy : Some Initial Results". UIFP Technical Paper UIFP/81/001. University of Ibadan, Ibadan.

Olofin, S.O., (1977), A Tentative Specification on an Econometric Model of the Nigerian Economy, Department of Economics, University of Ibadan, Ibadan (MIMEO).

----------, and N. Ekeoku (1985), Ex-Post Analysis of Government Fiscal Policy (1975-1981) with CEAR Model MAC III in S.O. Olofin (ed.) Modelling Nigerian Economic Development (Ibadan: University of Ibadan Press)

----------, & J. Iyaniwura, (1983), "From Oil Shortage to Oil Glut: Simulation of Growth Prospects in the Nigerian Economy", **Journal of Policy Modelling,** 5(3).

----------, J. Iyaniwura, J. Adeniyi and S. Olayide (1985), "The CEAR Model MAV IV" in S.O. Olofin (ed.), Modelling Nigerian Economic Development (Ibadan: University of Ibadan Press).

----------, J. Iyaniwura, D. Poloamina and N. Ekeoku (1983a) "Specification and Estimation of the CEAR MAC IV, Econometric Model of the Nigerian Economy". Centre for Econometric and Allied Research, University of Ibadan, Ibadan, DP-83-01

----------, J. Iyaniwura, J. Adeniyi, and S. Olayide (1983b) "An Operational Econometric Model of the Nigerian Economy", Centre for Econometric and Allied Research, University of Ibadan, Ibadan, DP-83-05

----------, N. Ekeoku, (1984a), "An Econometirc Simulation of Oil Policy in the Nigerian Economy", Ife Social Science Review,

----------, and N. Ekeoku, (1984b) "The Revised CER-FMNP MAC IV Model of the Nigerian Economy", Centre for Econometric and Allied Research, University of Ibadan, Ibadan, DP-84-02

----------, and Poloamina, (1984), "The Revised CEAR-MAC IV Macroeconomic Model of the Nigerian Economy", Centre for Econometric and Allied Research, University of Ibadan, DP-84-04

-------------------------, (1985), "Impact of Oil Quota Increase in the Revised CEAR MODEL MAC IV", in S.O. Olofin, (ed.) Modelling Nigerian Economic Development (Ibadan: University of Ibadan Press)

----------, M.I. Raheem and O.F. Akinkugbe (1985), "A Sub-model of Capital Flows" in S.O. Olofin (ed.) Modelling Nigerian Economic Development (Ibadan: University of Ibadan Press)

Owosekun, A.A. and J.P. Cleron (1990) "A Long-term Systems Dynamics Model of the Nigerian Economy", Policy Analysis Department, FMI.

Policy analysis Department, (1987, 1988), "Report on Short-term Consultancy : Computable General Assistance Programme.

Raheem, M.,O.Ogunkola and S. Olofin (1991), CEAR Macroeconometric model of the Nigerian Economy MAC V. Centre for Econometric and Allied Research, University of Ibadan, DP-92-03

Sobodu, O.O. (1990), A Multiobjective Multisectoral Planning Model for the Nigerian Economy : A Doctoral Thesis Submitted to the Department of Economics, University of Ibadan, Nigeria.

Taylor, K.T. Yurukoglu and S.A. Chaudhry (1983), "A Macro Model of an Oil Exporter : Nigeria" in J.P. Neary and S. Van Wijinbergen (eds.), Natural Resources and the Macroeconomy, Cambridge Mass, MIT, Press.

UNCTAD, (1973) Model of the Nigerian Economy, in the International Linkage of National Economic Models (ed.) F.J Ball. Amsterdam : North-Holland Pub. Co.

Uwujaren, G.P. (1977a), A Macroeconometric Model for Development and Planning of the Nigerian Economy, Unpublished Ph.D Dissertation, Columbia University, New YOrk

----------, (1977b), Specification and Estimation of an Economy-wide Macroeconometric Model of Nigerian, Nigerian Journal of Economic and Sosial Studies, 19(2) : 107-134

World Bank (1974) Long-term Projection Model of the Economy, in Nigerian Options for Long-term Development, John- Hopkins Press Baltimore.

PAPERS IN THIS SERIES

S. Olofin, A. Iwayemi, CEAR's Work Plan. Terms of Reference, Project Paper **[PP92-001]**, CEAR, University of Ibadan, Ibadan Nigeria, Jan. 1992.

A. Adenikinju, A. Jerome, O. Ogunkola, S. Olofin, A Survey of Existing Models of the Nigerian Economy, Project Paper **[PP92-002]**. CEAR, University of Ibadan, Ibadan Nigeria, Jan. 1992.

J. Iyaniwura, S. Dittoh, C. Iwunor, A. Aromolaran, Calssification Scheme for the Nigerian Social Acounting Matrix (SAM), **[PP92-003]**. CEAR, University of Ibadan, Ibadan Nigeria, Jan. 1992.