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GUIDEINES FOR DEVELOPING A REGIONAL MODEL AND FORECASTING SYSTEM.

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GUIDELINES FOR A REGIONAL MODEL AND FORECASTING SYSTEM: A NOTE

by

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INTRODUCTION

In the present competitive environment policy-makers are no longer satisfied with mere speculations about the direction of movement in major macro and micro-economic phenomenon but instead demand more tangible predictions from economists about the magnitude of variation in major macroeconomic aggregates. The intention of this note is to suggest some guidelines to modelbuilders and forecasters in the region on how the process of designing a forecasting system for CARICOM countries should proceed. Section 1 of the paper examines the genesis of modelbuilding in the Caribbean and briefly outlines the basic philosophies and approaches which have informed the modelbuilding process. Section 2 discusses a structured approach to modelbuilding and forecasting in an integrated economic environment while Section 3 outlines the minimum requirements for a successful forecasting model in the CARICOM region.

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1 The views expressed in this note are solely those of the authors and in no way reflect the views of the institutions they represent.

SECTION 1: CARIBBEAN EXPERIENCE WITH MODELBUILDING AND FORECASTING

The construction of modestly sized econometric models of the Caribbean economy has had a rather short genesis. The early models of the Caribbean economy were simple specifications of a recursive nature which devoted little emphasis on capturing the interrelationships in the economy. The framework adopted for testing was relatively rudimentary and these models can best be described as "academic exercises" aimed at introducing the elements of econometrics to the Caribbean Society. Models of this genre include the early studies of Carter (1970), Harris (1970) and Manhertz (1971) for Jamaica, and Persad (1975) and Gafar (1977) for Trinidad and Tobago. There were no models at this early stage for Guyana and Barbados.

During the 1980s there was a marked shift in econometric modelling towards the construction of systems which captured feedback effects in the economy (closed-form models). The pioneering attempts included the Holder-Worrell (H-W) model of Barbados [Holder and Worrell (1985, 1987)], the Open Trinidad Petroleum Model (Maraj (1987)), CBMOD1 of the Central Bank of Trinidad and Tobago [Hilaire, Nicholls and Henry (1990)] and Ganga's (1990) formulation for Guyana. These were followed in the early 1990s by the Trinidad Planning Model [Clarke and Watson (1992)]); The Trinidad ILPES model (St Cyr and Charles (1992); and most recently Leon et al's (1994) model for the ECCB area. The Holder-Worrell model which utilized as its key theoretical apparatus, the tradeable/nontradeable dichotomy, was designed to test the appropriateness of this paradigm for the Barbadian economy. As a result, there was a greater emphasis in this model on the fit of functional specifications rather than on policy scenarios and/or forecasting. Unlike its Barbadian counterpart, CBMOD1 was designed to explicitly analyze policy scenarios and to forecast the likely trajectory of the major macro-economic aggregates in Trinidad and Tobago[2]. The construction of both these models was directly constrained by the database environment as well as by available computer resources. The H-W model (1987) of Barbados was developed using EAL on a PC-AT while CBMOD1 utilized a portable version of main-frame TSP. The Trinidad Planning Model was more ambitious in scope than its predecessors and consisted of some 136 equations, more than 75% of which were definitional and devoted more attention than any previous attempts to the data assembly phase[3].

In summing up the modelbuilding experience to date in the Caribbean, it is not unfair to state that all the models were largely built by academics who spent little or no time designing the correct environment for forecasting. The emphasis in most of the modelling attempts was on the issue of designing "estimable" systems for testing various hypotheses rather than on designing systems which offered policy analysts the ability to combine simulation and forecast results with their own expert knowledge, in a day-to-day environment. Indeed, by the beginning of the 1990s the large scale model attempts which had

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2 This forecasting exercise was a part of the Trends Analysis and Projection (TAP) which the Research Department of The Central Bank of Trinidad and Tobago undertook frequently to inform the planning process. See Christopher and Farrell (1990) for details on the TAP exercise.

3 This study utilized AREMOS, a modelbuilding programme with a relatively specialized database management. system.

experienced considerable popularity in the 1980s fell into disuse. Numerous reasons can be cited for this demise, the most important of which include (a) the lack of continuity in the modelbuilding cycle, (b) the inability of modelbuilders to communicate effectively their results to policy makers and (c) the rise of the General to Specific methodology which emphasized a return to the single equation tradition, with a greater emphasis on testing rather than on structural detail. The Central Bank of Barbados, for instance, shifted to this methodology in the latter half of the 1980s but was unable to effectively combine it with its overall policy and forecasting stance[4]. The detailed attempts at forecasting based on macroeconometric modelling slowed in most of the MDC Central Banks, aggravated, partly by an exodus of econometric specialists[5]. The question which needs to be resolved in light of the experiences with modelbuilding is how should the process of constructing models for forecasting and policy analysis proceed in the various Caribbean Central Banks.

SECTION 2: A STRUCTURED APPROACH TO MODELBUILDING

A comprehensive approach to designing a forecasting model in the Caribbean revolves around the following critical stages.

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4 Leon (1987) and Downes and Leon (1987) popularized this notion in the Caribbean but was unable to explicitly encourage the use of the methodology for policy analysis and forecasting.

5 For example, work on CBMOD1 stopped in Trinidad after the model Group was disbanded.

(1) Clear Delineation of Objectives

(2) Model Specification

(3) Database Design

(4) Choice of the Appropriate Computing Environment

(5) Estimation

(6) Testing

(7) Simulation

(8) Policy Analysis

(9) Forecasting

1. Delineation of Objectives

It is critical to understand the interplay of these stages if the modelbuilding exercise is to proceed smoothly. Perhaps the most difficult task is to obtain a clear set of objectives from policy makers. On most occasions, policy-makers are often too general about what they require and the model is expected "to explain, forecast, and do policy analysis on almost every conceivable policy shift". No model can operate at this very general level and there is a need for much clarity in the delineation of objectives.

On the regional front, there is some evidence that this issue of "targeting" is being actively considered. Quite recently, The CARICOM Council of Ministers emphasized the need for a Single Market in CARICOM based on Trade Integration while the Governors of the various Central Bank territories have adopted a two-staged approach to monetary integration, emphasizing the need for closer policy co-ordination among the various Caribbean territories. Category A countries (Bahamas, OECS and Belize) are expected to maintain sound macroeconomic policies - a stable exchange rate for 36 months, a sustainable debt-service ratio not exceeding 15% and 3 months import cover in foreign exchange reserves for 12 months. Category B countries (Trinidad and Tobago, Barbados, Guyana and Jamaica) are expected to effect rapid stabilization and adjustment to "cure inflation, restore external payments balances, rebuild foreign exchange reserves and restore growth". These decisions should form the backbone on which the modelbuilding and forecasting exercise in the Caribbean should proceed. These goals emphasize two dimensions. The first dimension relates to how individual countries should effect their stabilization, while the second underscores the need to synthesize national and regional objectives.

A major challenge that is likely to confront forecasters in the future is the likelihood that the objectives outlined may not remain fixed for any specific period of time. As circumstances in the external environment change, policy makers may make radical modifications to the set of goals. Modelbuilders and forecasters must ensure that the systems devised can quickly adapt to changes in the preference sets of their political bosses. CBMOD1, for instance, was designed to answer very specific policy questions (i.e. the effect of a devaluation and the implications of increased government expenditure). By the time the model was completed, however, there was a marked shift in emphasis towards debt management. This could not be readily accommodated by the model.

2. Model Specification

The major issue here relates to the question of what is the best theoretical framework and functional specification to organize the objectives of the policy makers. Several considerations arise when deciding on the most appropriate specification:

(1) Elaboration of the theoretical and a priori notions that would inform the linkages in the model.

(2) Identification of the relevant economic variables.

(3) Choice of appropriate functional forms

(4) Decision on the size of the model (Number of Equations)

(5) Relative Distribution of Behavioural, Definitional and Institutional Equations

The lack of an organized body of theory to allow appropriate specifications of the realities in Caribbean Economies is one problem that has affected consistent theoretical specifications. Should model specifications reflect Keynesian, Monetarist, Structuralist notions or should they mirror the interrelationships in the economy in a real or working sense irrespective of the body of established thought. There is no quick fix solution to this matter but ultimately the specification design will depend on the aims of policy makers. These aims should reflect targets for employment, growth in real GDP, foreign exchange accumulation and the rate of inflation. If we are genuinely interested in building a model that can guide the council of governors then a decision has to be made from the following choices:-

- A series of National "Stand-Alone" Models
- An Integrated Multiregional Model

A national stand-alone model provides very specific "country" guidance on policy effects without knowing how agents in other countries react to policy decisions in the given nation. A multiregional model carries with it the distinct advantage of allowing feedback between the various national submodels and a Regional Economic Model. Diagram 2 presents the overall context diagram for this Regional Model. Each submodel can contain a specific general equilibrium design with the following broad structure:

1. PRODUCT MARKET

- Output of Major Industrial Sectors (SIC Classification)
- Behaviour of Major Firms

(Equations for Supply, Demand and Prices)

2. LABOUR MARKET

- Labour Demand, Supply and Wages
- Labour Migration

3. MONEY and FINANCIAL MARKET

- Money Supply and Demand
- Domestic Credit and Inflation
- Financial Integration (Interest Rate Behaviour)

4. GOVERNMENT BEHAVIOUR

- Direct and Indirect Taxes
- Current and Capital Expenditure
- External Debt Flows (Principal and Interest Payments)
- Government Budgetary Position

5. TRADE SECTOR

- Exports and Imports for selected 2-Digit Industries
- Tariff levels
- Reserve Levels, Exchange Rate and Common Currency

6. NATIONAL INCOME

Consumption and investment behaviour on a sectoral basis

The real issue is how best to specify the hooks between regional decision variables and national policy parameters. There is a large literature on this issue in the work of Baird (1983), Bolton [(1980a,b), (1991)], Issaev et al (1982), Courbis (1979) and Milne et al (1980) which offers useful insights to Caribbean "modellers". The standard approach is to build a regional system which includes the submodels as satellites in a top-down or bottom-up design. Overall regional performance can be gauged by some form of aggregation of individual performances. Natural candidate variables for this type of linkage effect include labour supply, the exchange rate, interest rates, imports, exports and prices.

3. Database Design and the Computing Environment

Quantitative data can be described in a formal sense as the numerical characterization of some important property of an object (in this case economic variables). Data is useless if it exists in an unstructured manner. The moment it is organized, one can glean useful "bits of information" on specific properties of economic phenomena. Although it is the life blood around which much of forecasting and policy analysis revolves, it has received the least attention among "modellers" in the region. For a long time, economists have complained about the problem of deficient data but have taken very few steps to rectify it. Indeed in some quarters, there is a perception that as long as a couple of software packages and microcomputers are acquired, the data constraint on modelling and forecasting is automatically resolved. Such a position may be tenable for a small academic forecasting exercise but is quite unsound for an organized modelbuilding and forecasting programme, especially among Regional Central Banks. Modelbuilders who have not participated actively in the generation of the data tend to be often content with its imperfections and tailor their specification to reflect the data constraint. Little by way of organized data mining has occurred among Caribbean forecasters. Griliches (1985a) sums up quite effectively the uneasy alliance between data and economists:

> " We did not observe them [data] directly ; we did not design the measurement instruments; and often we know little about what is really going on..... Most of our work is on "found" data, data that have been collected by somebody else, often for quite different purposes."

In the modelbuilding context the most challenging data problems that arise in the Caribbean relate to Missing Observations, Unrecorded variables, Insufficient periodicity of recorded data, Measurement errors and Short samples. These deficiency problems emanate from weaknesses in the data cycle (sourcing, preparation and dissemination) in the various territories. The logical approach taken by our colleagues in the world of computer data management can yield useful insights for economists and modelbuilders as to how these issues can be resolved.

In the computing sphere each entity in a specific system is identified with its requisite characteristics (data). These attributes usually exist in an unstructured form but are organized by a process of logical data modelling which defines domains for the attributes and allows a series of relational mappings among entities. Such a process permits easy combination of attributes for earlier analysis. This is what computer scientists refer to as a "database". Modelbuilders and forecasters need to spend therefore more time with their "data-mining" colleagues identifying relevant entities and attributes which impinge on the forecasting process.

Closely aligned to the issue of the development of an appropriate database environment is the choice of the appropriate information architecture to support the forecasting drive. Richardson, Jackson and Dickson (1990) have defined the basic elements of this architecture as one which reflects the interrelations between data, hardware, software and communications. The main elements of this type of system include:-

(1) Network/Communication Architecture

(2) Data Architecture

(3) Office Architecture

Modelbuilders in our region are generally not aware of how critical the existence of a good information environment is to successful forecasting. If a decision is taken to proceed with a multi-regional forecasting model, then these elements must be actively considered. A proper communication architecture would almost automatically guarantee rapid transmission of simulation results among individual economies. This communication architecture may take the form of "Local Area Networks(LANs)" in the satellite nations which are then linked via gateways to the Wider Regional Area Network (WAN). The housing of the network systems is also quite important and some attention must be devoted to identifying the appropriate infrastructure and equipment to support the Network/Communication and Data Systems.

4. ESTIMATION, TESTING AND SIMULATION

The estimation of the overall parameters of the model is highly dependent on the functional form and the nature of the system design. The preferred techniques are usually chosen from the class of Single Equation methods, Limited Information or Full Information system estimators. Single Equation estimators (SIEs e.g. OLS) utilize only the information contained in a given equation whereas Limited Information System Estimators (LISEs e.g. 2SLS) recognize that the equation of interest is part of a whole system and utilize therefore a limited amount of the information in the entire system. Unlike the SIEs and LISEs, full information methods (3SLS, FIML) estimate all the parameters of the system simultaneously.

The choice of the estimation technique is largely a function of the structure of the model's equations and of costs. If there is no simultaneity in the structural relationships, then OLS yields consistent estimates. If, however, simultaneity exists, the appropriate estimator must be taken from the class of systems estimators. The majority of large scale models that have been constructed in the Caribbean have utilized mainly Two-staged Least Squares (2SLS) and Ordinary Least Squares (OLS) as the principal estimators.

Within recent times, the framework for testing single equations has become more sophisticated largely as a result of the development of the General to Specific Methodology[6] and its link with cointegration (see Engle and Granger (1987), De Marchi and Gilbert (1989)). In the context of these developments, the Ordinary Least Squares estimator is super consistent in fully recursive systems. There is a problem, however, in utilizing this new methodology in the simultaneous equation environment and we are yet to witness the development of tests which suit this environment. In a simultaneous equation setting, the complex feedback relationships may introduce multiple orders of integration between variables and there need not exist any possibility for cointegration among various endogenous variables which admit multiple orders of integration. It is therefore not inconceivable in such systems to have variables which are I(2), I(1) and I(0) and for which no integrable set combination yields a set of I(0) variables. The procedure by Johansen (1988) only solves the problem in a multivariate sense and not in a multiple equation context. Critical to the estimation is the framework for evaluating the performance of the selected estimator. This environment should allow for testing:-

(a) Correctness of specification (Hausman, Rset)

(b) Particular data inconsistencies (stability, stationarity, autocorrelation, etc.)

(c) Overall Fit (F, LR, W, $\bar{R}^2$, etc.)

Once the specification, data assembly and estimation phases of

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6 This methodology emphasizes the notion of parsimony in the construction models.

modelbuilding process have been completed, the reliability of the model is determined by putting it through a series of validation tests, the most popular of which are historical simulation and sensitivity analysis. With respect to historical simulation, the intention is to determine how well the solved values of variables in the model duplicate the "true and actual behaviour" in the actual data. The Theil Inequality and its decomposition provide ready quantitative measures of how closely individual simulations track the original data.

This process of simulation is not as straightforward as it may appear since depending on the nature and size of the system convergence may be a slow process. Moreover, there is no correlation between goodness of fit of the individual equations and good simulation performance (see Klein and Young (1980) and Kmenta and Ramsey (1981). The issue of validation follows no "hard and fast rules" and more often than not modelbuilders are forced to trade off alternative validation criteria in different ways depending on the purpose of the model and the nature of the variables concerned.

5. FORECASTING

The aim of forecasting is to predict X_{n+h}, h=1,2,3 given a series of equally spaced observations X_t, t= 1,2,...n. In a large scale macroeconometric model the main challenge is to project accurately values for the endogenous variables in the system given assumptions about how the exogenous variables are likely to behave in the future. Large scale macroeconometric models utilize a relatively strong assumption about replicating the future from adequate knowledge of the past. This assumption of constancy is fine if the future evolve in a constant fashion. Forecasting accuracy, however, is a function of future, post-sample events which may undergo innumerable changes on account of unforeseen circumstances.

The main advantage of a formal forecasting method is not necessarily the prediction made but rather the process involved in arriving at the prediction and in the way they are interpreted and utilized. The accuracy of forecasting is therefore dependent on the "judgement" of the modelbuilder who may be required, based on his understanding of future events, to modify the forecast values within tolerable bands.

The macroeconometric modelbuilding environment should not provide the only guide to the future path of the economy. Indeed, it may often be helpful to combine this approach with a series of other methods which can be weighted depending on the preferences of the forecaster (Granger and Ramanatham (1984) and Holden and Peel (1986) have explained these notions).

Although the Trends, Analysis and Projection exercise of the Central Bank of Trinidad and Tobago generated both econometric and judgmental forecasts, there was no explicit process of weighing the importance of the methods based on the preferences of policy makers.

SECTION 3: MINIMUM REQUIREMENTS FOR A SUCCESSFUL FORECASTING STRATEGY

The achievement of a relatively successful forecasting system in CARICOM hinges on the expert blending of sound judgement, economic theory and a sophisticated information architecture with a systematic approach to economic modelbuilding. These requirements, however, are neither necessary nor sufficient to guarantee the occurrence of a "accurate forecast". Indeed, absolute accuracy in forecasting is seldom the pertinent issue, unless of course the forecaster is "omnipotent" - a trait which can only be ascribed to the creator. However, a structured approach to forecasting may often pay useful dividends if policymakers are able to anticipate the magnitude and direction of movement in economic variables.

The main elements for building a successful model involve:-

(a) A relatively sophisticated Information Architecture

This infrastructure should involve the provision of "proper" office facilities in addition to appropriate hardware and communication systems to support the forecasting drive. If the RPMS centre in Trinidad is to serve as the Regional hub for a forecast model, then two developments, namely the UWI networking project and the networking of the various Central Banks, must be given special attention. Firstly, the St. Augustine Campus is in the process of establishing a Fibre Distributed Data Interface (FDDI) backbone (Ring topology) to allow access to a series of data villages at various locations on the campus. Secondly, various regional Central Banks are in the process of evaluating various networking options. The Trinidad and Tobago Central Bank has already put in place a Token Ring Local Area Network with Windows, Dos, Apple and Unix operating environments. No concrete details exist on the plans of other Central Banks with regards to their networking topologies and current hardware systems. The modelbuilding and Forecasting Project will therefore require a relatively open-ended hardware system to allow effective system integration between the Hub and remote sites. A tentative design isuggesteded in Diagram 3. This design caters for a Local Area Network based on a client-server configuration. The server must possess a large fixed disk with sufficient RAM and a built in modem for communication.

(b) Appropriate Database Management and Modelling system

Serious forecasting requires a well-developed database system which is flexible enough to allow the modelbuilder to manipulate the data items in the most convenient form. Such a system should contain facilities for:-

- Creating Data Entry Forms
- Performing validatory checks on data items
- Full Screen Data Entry
- Sorting, Matching and Merging Records
- Manipulating any data periodicity
- Handling thousands of data items
- Producing high resolutions graphics in 2D and 3D
- Producing an integrated report with text tables and graphics
- Performing extensive data exchange on CD-ROM, disks, etc.

This database system should also allow for easy interfacing with a series of specialized modelbuilding packages such as TROLL, RATS, TSP, SPSS and SAS. The modelbuilding packages should contain facilities for addressing external libraries (in C, Pascal, etc.) to code new developments in estimation and testing procedures.

(c) <u>A Team of committed specialists</u>

This team would be charged with the responsibility of revamping submodels where they exist and building new models that can feed into the forecasting process.

CONCLUSION

Although Caribbean economists have been involved in the construction of national economic models since 1970, the process of modelling has not contributed significantly to policy analysis and forecasting. This note explored the requirements for a successful forecasting system emphasizing a more concerted effort on developing data and systems architecture. The drive toward the single market economy presents the region with a splendid opportunity to develop a Regional Model which can be linked to various national submodels in a top-down or bottom-up design. The models should enable a greater understanding of how regional policy parameters affect the individual economies of CARICOM.

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DIAGRAM 1: MODELBUILDING STAGES

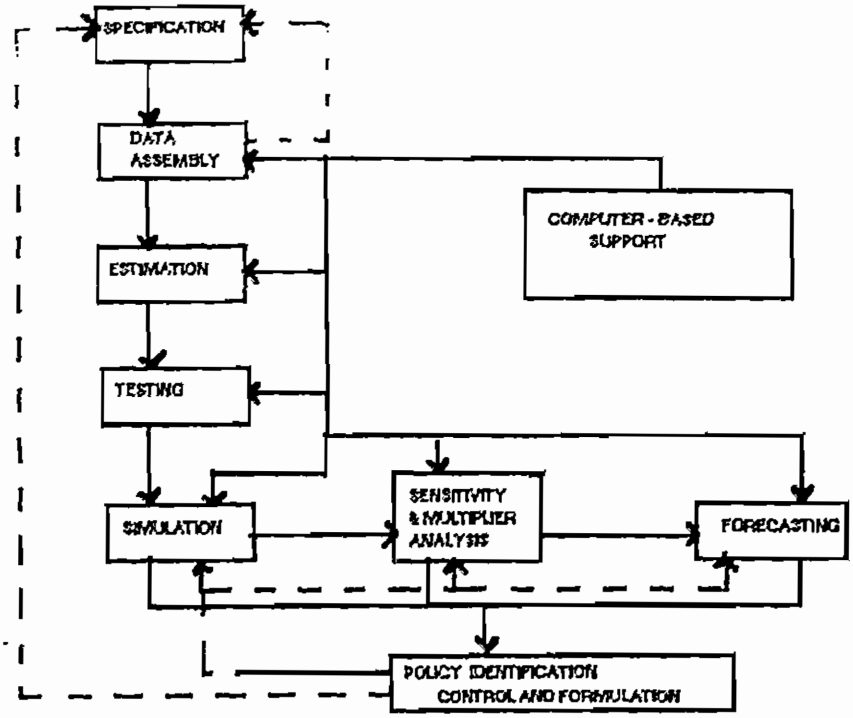

DIAGRAM 2: REGIONAL MODELLING SYSTEM
(OVERALL CONTEXT)

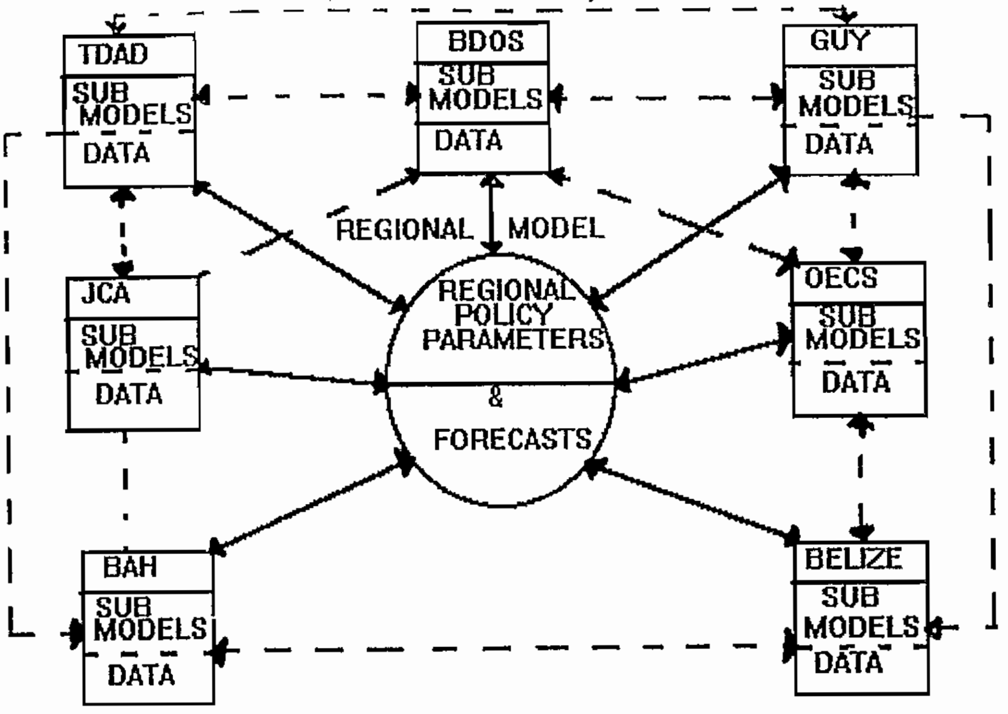

DIAGRAM 3: OFFICE ARCHITECTURE