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Abstract: This paper suggests requirements for a successful forecasting effort in the Caribbean. Recommendations include the need for institutional commitment to the modelling effort, an integrated resource approach both within institutional departments and across regional insitutions, and a more concerted effort on developing data and system architectures. It is argued that a structured approach to modelling, and a forecasting environment that fosters collaboration of effort and dissemination of results and skills is necessary. A review and critique of previous macroeconometric models in the region is provided.

Keywords: forecasting environment; information architecture; integrated resource approach

Introduction

The set of general equilibrium models, first developed by Léon Walras and later extended by Vilfredo Pareto in the late nineteenth century, provided the foundations of macroeconometric modelling. At its origins, the Walrasian system was conceptual and was not subjected to empirical study by its creators. Empirical testing of macroeconomic models was initiated by Jan Tinbergen on the Netherlands economy[1]. However, major developments took place just after the second World War when Jacob Marschak organised a research team at the Cowles Commission (then at the University of Chicago, now at Yale University in the USA) to study three interrelated themes: economic theory (model specification), statistical inference (model estimation, testing and application), and model construction (including data preparation and numerical calculation). Shortly afterwards similar developments took place in the Netherlands at the Central Planning Bureau, under Professor Tinbergen[2].

Since the initial work on the Netherlands and the US economies, a great deal of research time and effort by both national and international organisations have gone into the refinement and development of macroeconomic models for these and other developed countries (see Bodkin, Klein and Marwah (1991) and Driehuis, Fase and Den Hartog (1988)). These models, widely used both within and outside the government sector, have been constructed for many purposes: historical analysis, forecasting over a variety of possible horizons, policy formulation and evaluation, the testing of economic theories, and indeed, the elucidation and development of economic theories.

The International Monetary Fund is one international organisation that has encouraged the development of such models in developing countries. Macroeconomic modelling on developing countries at the Fund dates back to the 1950s and 1960s when J.J Polak and E. Walter Robichek, inter alia, presented basic formulations of the monetary approach to the balance of payments. The new generation of models by the Fund represent efforts to specify and estimate models that incorporate many of the key structural and institutional characteristics, for example, lesser developed equity and capital markets, and foreign exchange constraints, that differentiate developing countries from most developed countries (see Khan, Montiel and Ul Haque (1991)).

Aware of the special peculiarities and the importance of macro models for forecasting and policy analysis, Caribbean economists started model building in the 1970s. Examples of these early attempts include Harris (1970), Carter (1970) and Manhertz (1971) for Jamaica, and Persad (1975) and Gafar (1977) for Trinidad & Tobago. These efforts at modelling were fairly well rooted in the tradition of the open Keynesian economy (Kennedy (1966)) or, perhaps, more accurately, were examples of open Hicksian type IS-LM models (although some were more IS than LM). This, after all, was the tradition emanating from the metropolitan centres and, in all fairness to these pioneers, the very limited statistical data base that existed at that time clearly favoured the construction of such models. On the odd occasion, and in deference to the "Caribbean reality", one or two "supply side" equations, ostensibly to explain employment or production, were thrown in for good measure.

Whatever the philosophical content of these early models, it is perhaps more worrisome that, from the earliest forays of Caribbean scholars into this domain right up to the present time, models seemed to be constructed more for the intellectual thrill of the exercise than for any other end use to which the model could be put. A cursory glance at the works cited above would reveal that efforts were limited to the specification, estimation and validation of the models. This of course, is not a useless exercise, but modelling counterparts in the developed centres were going (at least) one step further: they were constructing models particularly for the end use of forecasting and, relatedly, policy evaluation. In fact, the market for econometric forecasts grew tremendously in the 70's with actors in both the public and private sectors participating (See, for example, Klein and Young (1980) and U.S. Department of Commerce (1986)).

To be fair, Caribbean modellers always recognised the potential usefulness for forecasting of the models they constructed and, indeed, there was some small attempt to do just that in Harris (1970). But these efforts have never been as sustained nor as systematic as those done by, say, the Wharton School, the Bureau of Economic Analysis, and the Reserve Bank of New Zealand (see Brooks and Gibbs (1991)).

There has been a resurgence of macroeconometric modelling in the English speaking Caribbean in recent years, and the efforts are much more sophisticated than those of the previous years. Moreover, these models were specifically developed for forecasting and include Belchere (1988) for the Bahamas, Maraj (1987), Hilaire et al. (1990), Clarke and Watson (1992) and St. Cyr and Charles (1992) for Trinidad & Tobago, UNDP (1991) for Jamaica, Ganga (1990) for Guyana, and Leon and Samuel (1994) for the ECCB area. Prototype models geared for generating forecasts of Caribbean type economies, such as ILPES (1986) and Worrell and Holder (1987), have also appeared. Still, however, useful output is not forthcoming and, apart from some attempts of the original model builders in one or two of the cases to use the model for forecasting, the efforts have once again been limited to the specification, estimation and validation of the models.

As macroeconomic modelling in the Caribbean region continues to develop, there is need to establish a structure to guide its evolution. The importance of a systematic approach is indicative of the present competitive environment as the region as a whole enters the larger world-wide net. Indeed, policy-makers are now demanding more tangible predictions from economists about major macroeconomic aggregates instead of mere speculations on the direction of movement of economic variables.

This paper[3] attempts to provide some guidelines aimed at improving the development of forecasting in the Caribbean region and provides a critique of past model buiding efforts. Section I of the paper discusses a structured approach to model building. Section II examines the genesis of modelbuilding in the Caribbean and briefly outlines the basic philosophies and approaches which have informed the modelbuilding process. Section III outlines some minimum requirements for successful forecasting in the Caribbean region.

I A Structured Approach to Macroeconometric Forecasting

A comprehensive approach to designing a forecasting system in the Caribbean should encompass:

(i) Clear Delineation of Objectives
(ii) Database Design and Choice of Appropriate Computing Environment
(iii) Model Specification
(iv) Estimation and Testing
(v) Forecasting, Simulation and Policy Analysis

In this section, we outline a host of issues that have to be considered in designing a structured macroeconometric forecasting system.

1.1 Delineation of Objectives

It is critical to understand the interplay of these stages if the model building exercise is to proceed smoothly. Perhaps the most difficult task facing the modelbuilder 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 carry out policy analysis on almost every conceivable policy shift". No model can operate at this very general level and there is need for much clarity in the delineation of objectives. These objectives should clarify the responsibilities of the forecasting group and include statements on the level of detail desired, the frequency of reporting and the tolerace levels to be used in evaluation.

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, emphasising 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 stabilisation and adjustment to "cure inflation, restore external payments balances, rebuild foreign exchange reserves and restore growth". Concrete decisions of this type should form the background against which the model building and forecasting exercise in the Caribbean should proceed. These goals emphasise two dimensions. The first dimension relates to how individual countries should effect their stabilisation, while the second underscores the need to synthesise national and regional objectives.

A major challenge that may confront modelbuilders 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 tend to make radical modifications to the set of goals. Modelbuilders and forecasters need to ensure that the systems devised can quickly adapt to changes in the preference sets of their political leaders. CBMOD1, the Central Bank of Trinidad and Tobago model, for instance, was designed to answer very specific policy questions, namely, 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 change in policy could not be accommodated readily without a substantial redesign of the relationships in the model.

1.2 Database Design and the Computing Environment

Quantitative data can be described in a formal sense as the numerical characterisation 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 organised, 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, little by way of organised data mining has occurred among Caribbean forecasters. Griliches (1985) 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."

Modelbuilders who have not participated actively in the generation of data tend to be often content with its imperfections and tailor their specifications to reflect the data constraint. In some quarters, there is even a perception that as long as a couple of software packages and powerful microcomputers are acquired, the effects of data constraints on modelling and forecasting can be ignored. Whereas such a position may be tenable for a small "academic" forecasting exercise, it is quite unsound for an organised model building and forecasting programme at any of the region's Central Banks.

In the model building 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 deficiencies emanate from weaknesses in the data cycle (sourcing, preparation and publication) 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 in the resolution of some of these issues.

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 organised 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 combinations of attributes for further analysis. This is what computer scientists refer to as a "database". Modelbuilders and forecasters, therefore, need to spend more time with their "data-mining" colleagues identifying relevant entities and attributes which impinge on the forecasting process. It is imperative that the process of data requests, compilation, publication and usage be informed by regular interaction among the users and compilers of economic data. The setting of priorities and foci would naturally be related to ongoing ultimate objectives that the mode builders seek to address.

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

1) Network/communication architecture
2) Office architecture
3) Data architecture

Network architecture refers to [ADD]... while office architecture incorporates ..[ADD]... Data architecture includes ..[ADD]... Modelbuilders in our region must become aware of the critical importance of a good information environment to successful policy modelling and coordination. In fact, any attempt at integrating the efforts of individual policy units must consider the elements of information architecture. In particular, a proper communication architecture would almost automatically guarantee the rapid transmission of data, in a generic sense, among individual units. This communication architecture may take the form of "Local Area Networks (LANs)" in the satellite nations, which would be linked via gateways to a Wider Regional Area Network (WAN). In addition, some consideration would have to be given to the housing of the network systems and to the identification of the appropriate infrastructure and equipment to support the Network/Communication and Data systems.

1.3 Model Specification

Given the objectives of interest, the model builder attempts to construct a model that will form the basis of decision making. A model is an abstraction of reality, a simplification of the real world. An economic model consists of behavioural relations, technological relations and identities or definitional relations. Behavioural relations are forces thought to determine the behaviour of the various groups of economic agents. Technological relations describe the restrictions imposed by the current technology and endowment of the system. Often technological relations, such as the production function, are not explicit in the model, but would have been used to derive behavioural relations such as the demand function for labour. Identities or definitional relations are self-explanatory.

Econometric models are economic models in an empirically testable form. This generally means augmenting the deterministic component of the behavioural equations with stochastic disturbances to capture observed variations in the data that are unaccounted for by the approximation to the complex process generating the data. These disturbances can be viewed as catch all terms representing all the variables considered irrelevant for the purpose of the model, as well as errors due to inaccurate functional form specifications, and measurement errors in the variables being explained. In order to make a probability statement or inference about the wider population parameters of interest from the specific sample being described, classical theory requires a specification of the probability distribution of the disturbances. The most general form of a simultaneous equation macroeconometric forecasting model may be represented as:

$$F(y_t, y_{t-1}, \cdots, y_{t-m}, x_t, x_{t-1}, \cdots, x_{t-n}; \beta) = \mu_t \qquad (1)$$

where $y_{t-i}, i = 0,1,\cdots,m$, are vectors of current and lagged values of endogenous variables and $x_{t-j}, j = 0,1,\cdots,n$, are vectors of exogenous variables. β is a matrix of (generally unknown) coefficients and μ_t a vector of random disturbances.

Several considerations arise in the actual formulation of a macroeconometric model. These include:

(1) Elaborating the theoretical and a priori notions that inform the linkages in the model;

(2) Establishing a mapping from possible theoretical latent variables to observable counterparts;

(3) Choosing appropriate functional forms;

(4) Deciding on the size and composition of the model (number and type of equations).

The model to be estimated should reflect the broad structure of the economy and be informative on policy issues. However, policy analysis and recommendations from the model ought to be informed by simulations and should be tempered by analysis of the implications of model constraints, political sensitivities, and the socioeconomic framework, the gestalt of which cannot be included in the model. The need for documented analysis and a statement of model assumptions facilitates replication and cannot be understated.

The specification of the model is arguably the most difficult part of the exercise. Standard practice has been for the modeller to be guided by economic theory as well as his/her knowledge of economic structures and institutions in giving a specific structure to the general model defined by equation 1 above. Given the statistical database available, it is at this stage that questions about the size of the model (the level of disaggregation) and the dynamic structure of the equations should be addressed.

All this, of course, is easier said than done. First, it is not clear how the "relevant theory" ought to be defined. Should model specifications reflect standard Keynesian, Monetarist, or Structuralist notions, or what the great economists coming out of the Caribbean tradition tell us? Or is is what our own training as economits lead us to understand about the structure and functioning of Caribbean type economies? Are theoretical constructs of the "demand side" like consumption and investment analytically useful in the Caribbean context and what should be the appropriate modelling framework (multiplier-accelerator theory)? To what extent should our theorising be related to the end use to which the model is to be put and, in this case, shouldn't the approach to specification be more eclectic, using whatever theoretical notions might serve the purpose? Further, should we embrace Sims' (1980) "atheoretical" approach which uses Vector Autoregressive (VAR) models that require no greater knowledge or understanding of economic structure than "everything depends on everything else?"

This 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. We need specifications that are acceptable relative to some theoretical notions and perform adequately according to statistical criteria. The underlying assumptions should be clearly stated for internal model consistency checks and for post estimation validation. Ultimately, the specification design will depend on the aims of policy makers. The major issue, therefore, relates to the question of what is the best theoretical framework and operational functional specifications to address the objectives of the policy makers. These aims should, in the context of Caricom, reflect targets for employment, growth in real GDP, foreign exchange accumulation and the rate of inflation. If there is a genuine interest in building models that can guide the Council of Central Bank Governors, then a decision has to be made on how best to use the individual country models to attain that objective.

National models provide very specific guidance on within-country policy effects without providing a mechanism for gauging how activities are affected by policy decisions taken in other nation states. Although not discussed in this paper, a regional model has the distinct advantage of allowing feedback among the various national submodels; the overwhelming logistics for implementing a regional model would make it difficult to recommend such an option at this time. Abstracting from those inter-country linkages, each national model should contain a specific general equilibrium design with the following broad structure:

1. National Product and Income
   - Sectoral output
   - Consumption and Investment behaviour
2. Labour Market
   - Labour demand and supply
   - Wages
3. Monetary Sector
   - Money demand
   - Domestic Credit
   - Inflation
   - Non-bank Financial Intermediation
4. Government Sector
   - Direct and Indirect taxes
   - Current and Capital expenditure
5. External Sector
   - Exports and Imports
   - Capital flows
   - Reserves
   - Exchange rate

Data may not permit the construction of a model with all sectors fully accounted for. In fact, it would be desirable to proceed in a modular form with different sectors or subsectors having different degrees of disaggregation and completeness to reflect individual country structures and their main policy concerns. For example, a Trinidad and Tobago model may include production and trade equations for petroleum products whereas an OECS model may wish to focus disaggegation efforts in the production and trade modules on tourism and bananas[4]

1.3.1 Exogeneity and Causality

A premise of the Cowles Foundation Approach postulates that the classification of variables into "endogenous" and "exogenous" and the causal structure of the model are given a priori and are therefore untestable. This approach has, in recent years, been criticized on several grounds: (i) classification of variables into endogenous and exogenous is sometimes arbitrary; (ii) there are variables which should be included in the equation but are excluded so as to achieve identification (the Liu (1960) critique) and; (iii) at times the coefficients in a simultaneous equations model cannot be assumed to be independent of changes in the exogenous variable (Lucas (1976) critique). For example, if the exogenous variables are changed and agents anticipate the change, they would modify their behaviour accordingly.

Thus, there is a need to formally classify variables into exogenous and endogenous variables to remedy these criticisms. One solution, at least to the Lucas critique, is to make the coefficients of the simultaneous equation system dependent on the exogenous policy variables (Maddala (1992)). This makes the model a varying parameter model (See Maddala (1977)). Leamer (1985) and Engle, Hendry and Richard (1982) suggest redefining the concept of exogeneity to make it testable[5]. Engle et al (1982) provide three testable definitions of exogeneity: weak, strong and super. A variable x_t is said to be weakly exogenous for estimating a set of parameters β if inference on β conditional on x_t involves no loss of information. Super-exogeneity relates to the Lucas critique and requires x_t to be weakly exogenous and the parameters in the joint probability distribution of y_t and x_t to remain invariant to changes in the marginal distribution of x_t. If x_t is weakly exogenous and x_t is not preceded or Granger caused by any of the endogenous variables in the system, x_t is defined as strongly exogenous. Granger's (1969) definition of causality is based on the notion that the future cannot cause the past but the past can cause the future, and relates to dynamic stochastic systems in terms of a predictability criterion. Methods exist for testing both Granger causality and exogeneity. Granger causality from x_t to y_t generally translates into a regression of y_t on lagged y's and lagged x's and testing whether the coefficients of the lagged x's are jointly zero. Tests for exogeneity depend on the availability of extra instrumental variables and involve adding these constructed variables to the original equations and testing that the coefficients of these added variables are jointly zero (see Maddala (1992)).

1.3.2 Identification

The identification problem is concerned with estimating the parameters of the model. It appears when more than one theory is consistent with the same "data" and there is no way of distinguishing them. In other words the theories are observationally equivalent or the structure of the model is unidentified (see Hsiao (1983) for a useful survey). The classic example given follows from Working (1926) in which there is no knowledge of conditions of supply and demand beyond our belief that the data represent equilibria. With only the data there is no way of determining which of the theories (supply or demand) is correct. Thus, the structure underlying the data is unidentified.

Identification can be established if the structural parameters can be derived from the known reduced form parameters[6]. If the reduced form coefficients imply two or more distinct values for a single structural parameter the model is said to be overidentified. If unique numerical values of the structural parameters of an equation can be obtained, the equation is called exactly identified. Underidentification, the last category, refers to the case discussed earlier where it is not possible to determine the structural parameters from the reduced form coefficients. The difference between overidentified and exactly identified equations is simply that the latter are easier to estimate than the former[7].

In linear simultaneous equations models, a necessary condition for the identification of an equation is the order condition which states that the number of variables missing from the equation but included in the system should be greater than or equal (according to whether the model is over or exactly identified) to the number of endogenous variables in the equation minus one. To this counting rule, one must also check the rank (sufficient) condition which is based on the structure of missing variables in the other equations.

1.3.3 Functional Form

Usually there are several ways of formulating the econometric model from the economic model. One reason for this is that there may be several functional forms which are consistent with the theory. Although economic theory may sometimes indicate the nature of a function, we often rely on statistical methods to determine the functional form consistent with the observed data. Models can be linear or non-linear, static or dynamic, and structured in levels or differences.

Most model builders are likely to favour linear models because they are easy to estimate. However, such functions may not always fit the data very well, thus resulting in large estimation and forecasting errors. Non-linear models, on the other hand, are generally difficult to estimate and manipulate (see Greene (1991) for a lucid discussion on tests for functional form).

Earlier modellers (see Boamah (1980)) suggested that whether a model is structured in levels or first differences depends on whether it is to be used for short-term or long-term forecasting. For short-term forecasting, it may be appropriate to analyse the system in rates of change of variables. Recent research suggests that it is necessary to determine the properties of the series over time as this may have implications for estimation and inference. For example, the fact that many economic time series are nonstationary in the sense that the mean and variance depend on time, renders inference on equations estimated in levels misleading. However, a linear combination of these nonstationary variables may be stationary, thus allowing OLS estimation.

Economic theory is generally silent about dynamics. The dynamics has to be determined from the statistical methods employed. In this respect, error correction models, which encompass many static and dynamic structures, are becoming quite popular (see Charemza and Deadman (1992) and Cuthbertson, Hall and Taylor (1992)).

1.3.4 Simple and Complex Models

Many scientists (for example, Popper (1959) and Friedman (1953)) have a preference for simple models as they are easier to understand, communicate and test empirically with data. However, as Maddala (1992) notes, "the choice of a simple model to explain complex real world phenomenon leads to two criticisms: (1) the model is oversimplified, and, (2) the assumptions are unrealistic". For example, to say that the demand for money is only a function of the rate of interest is an oversimplication and also an unrealistic assumption. To the criticism of oversimplification, Koopman (1957), for example, argues that it is better to start with a simplified model and progressively construct more complicated models. On the other hand, economists like J.D. Sargan and David Hendry of the London School of Economics tradition favour starting from a very general model and simplifying it progressively based on the data (see Granger (1990)).

Regarding the criticism of "unrealistic assumptions", Friedman (1957) argued that the assumptions of a theory are never descriptively realistic. Therefore, "the relevant question to ask about the assumptions of a theory is whether they are sufficiently good approximations for the purpose at hand. And this question can be answered only by seeing whether the theory works, which means whether it yields sufficiently accurate predictions".

The choice of a simple or complex model must also depend on the intended purpose. The model builders should weigh the benefits against the costs of building and continually updating the model.

1.4 Estimation and Testing

When the model has been specified we can proceed to test the empirical validity of the economic model. Several issues are involved relating to measurement and method of estimation.

1.4.1 Measurement Problems

Economic theory is not limited to the available data. Further, concepts developed in economic theory are not conditional upon being measurable. This often results in economic hypotheses being formulated in terms of unobservable variables. Consider, for example, the following:

$$C_t = \alpha_0 + \alpha_1 Y_t^P + \alpha_2 r_t + \alpha_3 H_t + \alpha_4 P_t^e + \mu_t \qquad (2)$$

where C is consumption, Y^P is permanent income, r is the rate of interest, H is the ratio of human capital to total wealth and P^e is expected inflation. Measurement of each one of these variables presents problems. In practice, C is usually measured by consumers' expenditure on non-durables, which differs from actual consumption in that it does not allow for the flow of services from durable goods; Y^P is not directly observable and is usually approximated by a weighted average of present and past values of measured income with geometrically declining weights - an ad hoc approximation which is far from satisfactory. The choice of the appropriate rate of interest (nominal or real, short-term or long-term) for an aggregate function is in the last instance an empirical matter. Furthermore, data on wealth if available at all, are not reliable (see Arestis and Hadjimatheou (1982)). As a result H is measured by proxy variables (such as the ratio of earned income to total income) which do not do justice to the theoretical concept. The final regressor, P^e, is also non-observable; notwithstanding the problems of measuring the actual rate of inflation, the expectation generating functions employed in practice, including adaptive and extrapolative expectations, are mostly ad hoc devices which leave the issue open.

Other data considerations include the length and unit of time. In order to ensure consistency of estimation, especially in simultaneous estimation techniques, the number of degrees of freedom, that is the number of unspecified parameters of the joint distribution, must be sufficiently large. The unit of time used would generally be determined by the nature and use of the model. For instance, there would not be much use for an inventory model based on annual data if in reality manufacturers adjust their production and stock quarterly.

Problems of measurement and unobservable variables are widespread in economics and are particularly apparent in developing countries. Whenever they occur, their presence and importance should be admitted and the implications for any of the conclusions from the empirical research spelled out. One case in point is the assumption of subsidiary hypotheses when testing a particular hypothesis. The testing of such subsidiary hypotheses can question the generality and definitiveness of the conclusions of that specific hypothesis. For example, consider the empirical modelling of seasonal data. Until recently, the practice had been either to use seasonal dummy variables as additional regressors or to run regressions using seasonally adjusted data. We now know that the use of dummy variables are tantamount to imposing an a priori and ad hoc seasonal pattern which may be extraneous to the relationship being estimated. Also, seasonal adjustments distort some data characteristics that are unrelated to seasonality (Wallis (1974) and Prothero and Wallis (1976)). The most recent suggestion is to test for seasonal integration as a means of choosing between deterministic and stochastic seasonality. If a series is seasonally integrated, seasonal differencing would be the appropriate method of deseasonalisation (see Hylleberg (1990) and Craigwell, Leon and Mascoll (1994)).

1.4.2 Methods of Estimation

In fitting the model to the data, the choice of an appropriate estimating technique is very important. This aspect of modelling received a lot of attention in the 1950s and 1960s through the Cowles Foundation which spent a lot of time devising alternative estimation methods and computer algorithms. Estimation procedures can be classified into limited information methods and full information methods. Limited information methods (for example OLS) estimate one equation at a time while full information methods (for example, Full Information Maximum Likelihood) treat all equations and all parameters jointly. Asymptotic results suggest that all of these structural estimators should be preferred to OLS which, alone among the estimators, is inconsistent (see Greene (1991)). Unfortunately, samples are finite (moreso in developing countries) and in many cases OLS has a smaller variance about its mean than does 2SLS about its mean, leading to the possibility that OLS might be more precise on a mean squared error criterion. For these reasons OLS is often used (See Watson (1987)). However, the fact remains that OLS standard errors are biased and in all likelihood, not useful for inference purposes. Other limited information approaches like 2SLS are preferred. Intuition would suggest that full information methods are superior to single-equation estimators and should be used given that the current state of available software has all but eliminated the computational simplicity advantage of single-equation methods. Why then aren't these methods used? First, any specification error in the structure of the model will be propagated throughout the system. The limited information methods will, by and large, confine a problem to the particular equation in which it appears. Second, Monte Carlo studies have indicated that the finite sample variance of the full information estimator may be as large as or larger than that of the limited information estimator (see Greene (1991)).

The choice of estimation technique is largely a function of the structure of the model's equations and 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.

Recently, the framework for modelling single equations has become more sophisticated largely as a result of the development of the general-to-specific methodology[8] and its link with cointegration (see Engle and Granger (1987), De Marchi and Gilbert (1989)). Leon and Samuel (1994) apply this methodology to a model of St Lucia but it is unclear how successful this approach has been since the model is still at a preliminary stage. Another example of the use of that methodology is the model of the Reserve Bank of New Zealand (Brooks and Gibbs (1992)). In the context of these developments, the Ordinary Least Squares estimator is super consistent in fully recursive systems. That property, however, does not translate to non-recursive systems where complex feedback relationships may introduce multiple orders of integration among a given set of variables. It is therefore conceivable for such systems to have variables which are I(2), I(1) and I(0) and for which no integrable combination yields a set of I(0) variables.

The use of the cointegration approach holds a lot of promise. In the first place, it imposes a framework for a dynamic structure which takes full account of the "equilibrium" or "long run" properties of the model. Second, the approach includes a "built-in specification test" because of the existence properties enunciated in the Granger Representation Theorem. However, there is a cost attached. First, the determination of cointegrating relationships can be a long process of establishing the orders of stationarity of all economic time series to be used in the model, and the tests may yield unsatisfactory results because of the short span of the data. Second, choosing an appropriate VAR structure may be problemmatic because data shortages may not allow different lag lengths; even when the data is adequate, the economic interpretation of the coefficients are not immediately obvious (see Charemza and Deadman (1992), p.201). Finally, although growing, the availability of software for the new techniques is still sparse: to date, MICROFIT (Pesaran and Pesaran (1991)), EVIEWS (Lilien et al. (1994)), PCGIVE Professional (Doornik and Hendry (1994)), RATS (CATS procedure (Hansen, Johansen and Juselius (1995))) and GAUSS (COINT (Phillips and Oularis (1995))) allow for estimation using the Johansen procedure.

1.4.3 Evaluation and Model Selection

Before the estimated model becomes operational, it should be tested for economic and statistical adequacy. The size and sign of parameters should be investigated to determine if they conform to the expectations of the theory. Tests or measures of the validity of restrictions, the explanatory and predictive power of the regression, the stability of the parameters, the size and pattern of residuals are criteria that can be used to evaluate and choose among rival specifications. The development of more recent tests (see Godfrey (1989)) has rendered the old practice of choosing between relationships entirely on the basis of the size of R^2, the coefficient of multiple determination, obsolete. It is now well known that a high R^2 does not establish causality and in fact can easily be achieved especially when any two variables are trending. In fact, it is not always the case that one can choose a model that fits the data well. If, for instance, the model is designed for forecasting purposes, the researcher may be forced to compromise, accepting some equations which, although less desirable from a statistical point of view, nevertheless help to improve the forecasting performance of the model. Thus, the primary purpose of the model plays a role in shaping its final form[9]. Another criterion for accepting a model is its encompassing ability, that is, its ability to explain relevant findings from other studies (see Mizon (1984)).

1.5 Forecasting, Simulation and Policy Analysis

Forecasting, in the framework of the general model defined by equation (1), is the estimation of the as yet unobserved y_{t+k}, $k = 1,2, \ldots$ given y_{t-k}, $k = 0,1,2, \ldots m$, x_{t-k}, $k = 0,1,2, \ldots, n$ and β. Ironically, it is probably the most misunderstood stage of the whole forecasting cycle and there is a widespread belief that this is a fairly mechanical exercise requiring not much more than interfacing with the computer.

Nothing could be further from the truth: there is a very rigid and disciplined routine to follow which requires, among other things, a lot of expert opinion and judgement about the future path to be taken by the exogenous variables in the model. This path may be known with some certainty in the case of certain variables, especially if the model is being used by some state agency like a Ministry of Planning, but it is likely to be unknown for variables which are of fundamental importance - like the price of oil in the case of Trinidad & Tobago. In the final analysis, the forecast will be as good as the assumptions made about the (usually numerous) exogenous variables in the model.

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 structural and parametric constancy is fine if the processes generating the observed data evolve in a constant and stable manner. Forecasting accuracy, however, is a function of future, post-sample events which may change on account of unforseen 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 utilised. The accuracy of forecasting is therefore dependent on the judgment of the modelbuilder who may be required, based on his/her understanding of future events, to modify the forecast values within tolerable bands. The pertinent issue now becomes how different are the model forecasts from the expectations of experts and how much adjustment needs to be made to the model.

In a standard set up, the best forecast of the disturbance in an equation is its mean value of zero. However, practical forecasts are not purely model based (zero projection), but are subject to non-zero residual adjustments called "constant adjustments" or "add-factors" (see Wallis (1989)). These adjustments are based on (i) the recent patterns of the residuals, (ii) available current information not yet incorporated in the model, (iii) data revisions, and (iv) information about likely future developments not already incorporated in the model; for example, if labour contracts are due for renegotiation, an adjustment may be necessary in the wage wage equation. Such adjustments are typically made in lieu of a respecification and reestimation of the model's equations, which are often impractical at that stage of the forecasting process. Residual adjustments are also used to "fix" solutions to meet a required data constraint; an example of this is when an add-factor is used to ensure that a forecast matches the value of an endogenous variable which is known before the forecast occurs. Adjustments are not necessarily limited to the endogenous variable of interest; a non-zero residual may also be incorporated in an equation of another endogenous variable which is related to the endogenous variable of interest. This mechanism can also be use to explore new scenarios or structural change that the model cannot account for. It is necessary in each case to trace the implicit extension that is being applied to the model; it aids understanding, ensures replicability and points to structural changes that may need to be incorporated later.

The macroeconometric model building 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 (see Granger and Ramanatham (1984) and Holden and Peel (1986)). 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 weighting the importance of the methods based on the preferences of policy-makers.

In macroeconometric models when all the diagnostic checks have been carried out on the model, the researcher may conduct experiments to further test the validity of the model and/or to predict the unobserved or future values of the endogenous variables[10]. This is usually done through the process of simulation. In the framework of equation (1) above, simulation involves the determination of the time path of the elements of the y vector given x and β[11]. An initial forecast, called the base forecast, is prepared and then another forecast, called a policy simulation, is recalculated after altering one or more of the exogenous variables. A comparison of the base and policy simulations shows how, conditional on the estimated model, the economy would be affected by the policy change. The rationale for the use of statistics based on simulation is that equation by equation evaluation does not capture the full richness of the simultaneous system and that, if the model is truly a representation of the process generating the data, then it should produce output that closely resembles the observed data. Intuitively, too, it would seem very plausible that a model purporting to forecast future values should at least be able to satisfactorily explain the past (see Watson (1987)). The issue of validation follows no "hard and fast rules" and more often than not, modelbuilders are forced to trade off alternative criteria in different ways depending on the purpose of the model and the nature of the variables concerned.

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 and forecast performance [see Klein and Young (1980) and Kmenta and Ramsey (1981)] Thus, emphasis on single equation simulation criteria may be misplaced. One global measure of a model's explanatory power is that provided in Smith (1977).

Ex-post simulation is conducted when the main interest is to test the validity of the model. The model is simulated through the estimation period and a comparison between the original data series and the simulated series of each endogenous variable can be made. Forecasting involves the simulation of the model beyond the estimation period. Two forms are often identified: ex-post and ex-ante forecasting. In ex-post forecasting the simulation begins at the end of the estimation period and extends to the present. Ex-ante forecasting, however, refers to the solution of the model from the current period into the future. Quantitative measures which help to gauge the tracking performance of ex-post simulation and ex-post forecasting include measures such as the root mean square error, the mean simulation/forecast error, the mean absolute simulation/forecast error and Theil's inequality coefficient and variance decomposition. Measures of ex-ante forecast performance are more complex as they require a process of stochastic or Monte Carlo simulation. Other measures used in evaluating models check for (i) the number of turning points the simulation/forecast missed and failed to predict as well as the number of under or over-predictions; (ii) the response of a given endogenous variable (target) to a change in an exogenous policy variable (instrument). Ideally, the response should conform to the theory and empirical observations (see Wallis (1989)); (iii) the sensitivity of the models to factors such as the initial period in which the simulation began and minor perturbations in the coefficients. These changes should have minor effects on the simulation or forecasting results.

What caveats should accompany policy prescription or forecasting? First, the estimated model is based on the available historical data. These are generated as products of the economic structure and can only be used for policy analysis on the assumption that structure does not change. For example, the UNDP model of the Jamaican economy uses data from 1974 to 1989 while the Hilaire et al. model of the Trinidad & Tobago economy was estimated on data from 1966 to 1986. Since the structure of these economies has undergone such radical changes in the very recent past, policy prescriptions based on these forecasts need to be interpreted with great care as the analytical usefulness of both the equations comprising the models and the estimated coefficients are no longer obvious. Second, forecasts have to be based on the estimated coefficients. Policy forecasts will therefore contain margins of error just as the estimated coefficients do. Further, even if the estimated model is adequate and the coefficients are precise, forecasts can still be wrong since they incorporate forecasts of the exogenous variables in the model, and because of changed "external" conditions that could not have been predicted or due to a change in policy that has affected model parameters (see Leon (1989)).

1.6 A Schematic Representation of the Steps in Model Building

We have discussed model building as if there is no interrelationship between stages 1 - 5 (Figure 1.1). There has, however, been considerable dissatisfaction with this scheme since the 1970s. It is ludicrous to assume that there is no feedback from the econometric testing of economic theories to the formulation of economic theories (i.e. from box 6 to box 1). Econometricians do not simply take the theories they are given and test them, learning nothing from the testing process. Similarly, the data collecting agencies do not gather whatever data is available and the econometricians use whatever data is given to them. In addition, it has been suggested that in testing hypotheses one assumes that the specification adopted in box 2 is correct in that tests are only made on the original economic model. The modelling process generally follows an up-down, down-up schema with feedback from the diagnostic checks to the original model specification and to the refinement of the econometric model. These new developments suggested are shown figuratively in Figure 1.2.

[Figures 1.1 and 1.2 about here]

2 A Review of Caribbean Macro Models

There are few formal macroeconomic models for policy use or policy evaluation in the Caribbean, perhaps because the notion of economic management is relatively new to the area. Systems can be divided into three categories: planning models, estimated statistical models and judgemental models. Planning models are based on input-output relationships, using linear programming techniques to establish feasible long-term paths for the economy. The sole Caribbean example of a model of this type is to be found at the Government of Jamaica's National Planning Agency[12]. Judgemental forecasts, as the name implies, suggest that the forecasts are based on forecaster's judgement. These types of models have been used by the IMF and the Central Bank of Barbados (see Worrell and Holder (1984)). Our main concern is the third class of economic models, that is, statistical econometric models[13]. We do not assess the models under review according to all the design criteria discussed in Section 1; rather, the emphasis is on the sector composition, size and scope of each study, points of similarities and differences with other models of the same economy, their main findings and the way in which each model 'hangs together as a whole'. A critical evaluation of these models as well as suggestions for improvement are provided.

2.1 Macroeconometric Models for Jamaica

As Table 1 indicates, the earliest efforts on macroeconomic model building in Jamaica used OLS or 2SLS as the estimating method. The frequency of the data was annual and the systems were essentially Keynesian; they incorporated the consumption function and attempted to estimate income multipliers, neglecting monetary effects. These models however recognised the importance of international flows to the Caribbean and the authors spent time examining the prominence of trade flows through imports and exports functions. Later models by Worrell and Holder (1979, 1984) considered not only a prominent tradeable goods sector but also the non-tradeables, banking and government sectors. None of these models has yet been used for forecasting by policymakers.

[Table 1 about here - Macromodels and their characteristics]

2.2 Macroeconometric Models in Trinidad and Tobago

The models for Trinidad & Tobago were developed along similar lines and are comparable in scope to those done on Jamaica. There was some discussion on the monetary sector and the supply-side of the economy, aspects lacking in the earlier models. As a result of their highly aggregative nature, these early models on Trinidad and Tobago were however smaller in size than their Jamaican counterparts. The later models of St. Cyr and Charles (1992) and especially Hilaire, Nicholls and Henry (1990) are particularly important as they generated ex-post simulation and forecasting results. The Jamaican models never reached this stage of development. Also important to Caribbean macro-modelling is the fact that the first and only attempt at estimating a quarterly model has been on Trinidad and Tobago although, as Boamah (1980) correctly observed, "even if one were to overlook the use of an inappropriate estimating technique (OLS), most of the results reported are themselves unacceptable from the view point of conventional means of statistical inference". Also, no attempt was made to consider the possible seasonal variation in the data.

2.3 Macroeconometric Models for Barbados

Of the three countries, modelling started last in Barbados. As a result, the theoretical construction of the early Barbadian models was fairly sound. Barbadian model builders seemed to have learnt from the weaknesses inherent in the models of Trinidad and Tobago and Jamaica. As a means of giving their previous judgemental approach a statistical basis, Barbadian model builders have sought to combine econometric, accounting and judgemental frameworks, thereby advancing model building in the region. These models have been used, with limited success, to provide medium term forecasts and ex-post simulations (see Galawish and Worrell (1988) and Craigwell, Haynes, Walker and Worrell (1993)).

2.4 Evaluation and Critique of Caribbean Macromodels

The macroeconometric models reviewed above collectively exhibit a great deal of similarities in both the theoretical structure and methods of estimation. Our purpose in this section is to present a general evaluation of the models from the perspective of

(a) theoretical underpinnings; and

(b) econometric considerations.

Some model specific issues are also addressed.

2.4.1 Theoretical Underpinnings

The discussion above highlights the 'incompleteness' of Caribbean macroeconomic theory. As Worrell and Holder (1984) writes, nearly "all these models were abandonned by their authors before they had captured sufficient interest to suggest adoption by policymakers and/or their critics .... the models in general did not yield sufficient insight into policy issues of most vital interest to decision-makers: exchange rates, fiscal policy, interest rates, central bank reserve requirements and exchange controls". Indeed, these models, especially the early models (pre-1980s) were basically of the neo-Keynesian genre, with their emphases on the demand side of the economy, and little or no discussion of the supply side of the macroeconomic structure. The problems facing developing countries like the Caribbean stem mainly from bottlenecks in production due to limited quantities of certain factors, such as human and physical capital, and relatively inefficient production techniques (Boamah (1985)). This problem, however, is not as great as in the 1960s and 1970s as later Caribbean models have not totally accepted the applicability of the Keynesian theoretical framework. St. Cyr (1991) has recently advanced working hypotheses on some recurring themes central to Caribbean economies. Our view is that where theory models are tentative, statistical techniques should be used to distinguish between exogenous and endogenous variables, to determine whether the model should be estimated in levels or differences, and whether the equations should be static or dynamic.

2.4.2 Econometric Considerations

We focus on two related issues: the data base and the estimation technique. The Caribbean studies mentioned above were typically estimated with 8 - 9 observations and occasionally 15 - 20 observations. Due to the paucity of the data, researchers also omitted several important relations, particularly functions related to the labour and financial markets (Worrell (1973), Boamah (1980)). In many cases, the data employed did not correspond precisely to the theoretical specifications, and some of the key series were at best imperfect, subject to both random and systematic measurement error.

All the above suggest that the results need careful interpretation, and could have given a distorted picture of the economic structure being estimated. As stated earlier, economists tend not to generate their own data and may be ignorant of the sources and consequences of most of its errors. Indeed, the lack of discussion on the biases transmitted to the estimates by the inadequate data suggest this is the case. Data seems to have been entered uncritically into the computer. Caribbean model building efforts would profit immensely if our trained economists (econometricians) became more involved in compiling data; we should be more concerned with ameliorating our data systems than in estimating what are usually rather simplistic equations employing rather poor data.

The small data sets also limit us in another area of 'best practice' econometrics. There is some dispute about the exact weight one ought to attribute to prior knowledge and to data evidence;

however, there is wide consensus that one should let the data tell part of the story, especially with regard to the dynamics of the model, as macroeconomic theory is often silent in this respect (Malinvaud (1981)). In-depth data analysis may provide insights on causal links and lag patterns; such an approach would undoubtedly enrich our specifications. However, the above macro studies would suggest that Caribbean econometricians pay scant attention to the dynamic properties of their models. This may have been necessary to avoid the familiar degrees of freedom and 'loss of power' problems due to limited data when lagged variables are included in the regressions.

Data mining is the term given to the process of determining a model's specification after confronting it with the data. As Rock (1984) observes, "due to the lack of a strong macro-theory, model formulation in the Caribbean seems to follow this iterative process: we postulate a (usually parsimonious) representation of our prior beliefs and confront this with the data. Often this preliminary exercise proves unsatisfactory and the model is revised.". Such specification searches may converge to the neighbourhood of the 'truth' especially when informed by established theory; however, one inherently risks estimating until at some (arbitrary) level of significance one discovers a 'significant' relationship from the sample data. As Johnston (1984) suggests, this significance may simply be a specious contrivance. In addition, such an (iterative) approach, strictly speaking, may well invalidate several of the assumptions underlying the approach to traditional inference (Leamer (1978)). Leamer proposes several appealing - essentially Bayesian - ways whereby the researcher can appropriately discount the final results of such specification searches. We do not discuss these here. In summary, one ought to take careful account of the data mining process since such procedures imply that the reported standard errors understate the uncertainty associated with the estimated coefficients - the rose may not be as real as it looks!

With respect to the estimating method, OLS is often used as the pragmatic choice. Asymptotically, OLS often gives inferior estimates (biased and inconsistent) relative to other limited information approaches like 2SLS in simultaneous equation models. The exception to the case being block recursive systems. Previous model builders recognised this point but failed to provide more discussion on why this outcome prevailed. The point is that analytical research on the small sample properties of the consistent (simultaneous equations) estimators, such as 2SLS and LIML, indicates that these estimators may possess undesirable finite sample properties; for example, the 2SLS estimators, under several commonly encountered conditions, possess a distribution that has no finite order moments. In addition, certain consistent estimators can have serious finite sample biases and may be outperformed by OLS on a mean square error criterion (Zellner (1979)). Nevertheless, these results do not necessarily imply that OLS is a good choice. There are many situations often encountered in empirical work that challenge the empirical suitability of the OLS estimator. Some of these are: (1) omitted variables; (2) use of unobservable variables, for example, expectations; (3) measurement error in the data; (4) stochastic misspecification; and (5) dynamic misspecification (see Hendry (1980)). Some research has emerged on identifying and dealing with many of these technical problems (Godfrey (1989)) and analysing the properties of estimators in finite samples (Phillips (1977)). An analysis of these problems are indispensable to a correct interpretation of our empirical results (see Watson (1987)).

The more recent studies[14] above show little evidence that many of these considerations were entertained. Further, "casual" modelling which ignores the above situations may even appear sound by the usual regression diagnostics (DW, R^2, 't'- and F- ratios). However, to accept OLS results on the basis of these statistics alone, and without deeper soul-searching, is a process fraught with danger. Granger and Newbold (1974) have clearly shown that when variables are run in levels, inference based on these above mentioned summary statistics may be misleading. In fact, in strict terms, the 'F' and 't' statistics are themselves invalid for inference under several of the above-mentioned conditions. Since the acceptance of the OLS results are conditional on these statistics, the assumptions underlying their validity become important. Godfrey (1989) has outlined several diagnostic tests (for example, exogeneity, paramater constancy, autocorrelation) to check the underlying assumptions of the least squares regression. The objective is to design models that are theory-consistent approximations to the process generating the data, and which mimick elements both of the past, present and future and are the measurement system that generated the observed data.

Another econometric problem which is not peculiar to Caribbean studies is the issue of non-stationarity. Conventional econometric theory has been developed upon the assumption that the underlying data processes are stationary . However, most economic variables do not exhibit constancy over time neither in mean nor variance, implying that classical statistical inference in general is not valid. Recent developments in econometric theory have shown that if a set of non-stationary variables is cointegrated, that is a linear combination of these variables is stationary - valid estimation and inference is possible. This stationary linear combination can be interpreted as a long-run equilibrium relationship. Thus, this econometric methodology[15] (Engle and Granger (1991)) can help ascertain the existence of the theoretical specification.

In addition to the general points raised above, there are practical shortcomings that should be considered in formulating models. For example, in Hilaire et al (1990) consumption, income, and imports are estimated using current prices, notwithstanding the fact that the period covers years of moderate to almost no inflation (the 60's) to years when inflation was as high as 22% (the 70's). In addition, some estimated equations did not recognise underlying identities. For example, Hilaire et al estimate the function

$$NDAT = -\underset{(x.xx)}{115.91} - \underset{(x.xx)}{1.006}\,BUD + \underset{(x.xx)}{1.108}\,NDAT(-1) \qquad (3)$$

[insert t-statistics here - edit Mathtype equation]

where *NDAT* = Net Domestic Assets of the Central Bank and *BUD* = Government's Budget Surplus[16]. The constant term (which should not have been used at all) is not significant while the coefficients of *BUD* and *NDAT*(-1) are not significantly different from -1 and 1 respectively, their correct values derived from the identity *NDAT* = *NDAT(-1) - BUD*.

Depending on the objectives of the model and the requisite level of disaggregation, a choice can be made regarding the desirable mix of behavioural equations and identities. Some authors prefer using identities to estimated equations wherever the former are possible. For example, whereas tax revenue functions are generally estimated as:

$$Tax\,Revenue = \alpha + \beta\,Tax\,Base \qquad (4)$$

the identity *Tax Revenue* = *Average Tax Rate* * *Tax Base* could be a preferred alternative; the average tax rate could be deduced from the data.

If the model is to be used for policy making purposes, the use of the identity instead of the equation 4 provides a very powerful policy instrument: the average tax rate. The fixed value for β clearly does not provide for this possibility.

It is particularly important that fundamental accounting identities of the economic system be incorporated into the models. A failure to do this makes it unclear whether sectoral linkages are satisfied. In addition, assumptions implied by data constraints must be fully recognised. For example, we cannot claim no assumption of money market equilibrium when the data does not distinguish between money demand and money supply and the same money series is used to model both demand and supply functions. Further, where data series, not available in published sources, are compiled for the model building exercise, the procedures used should be clearly stated. Not only is replicability facilitated, but the accuracy and interpretation of the results will depend on the validity of the constructed data.

Simulation results must also be interpreted with great care. In Hilaire et al (1990), when the model was simulated to determine the effects of a fall in oil prices, the model predicted that domestic prices would rise. The corollary to this, of course, is that a rise in oil prices would result in a slow down of domestic inflation, a result which, in addition to being counter intuitive, is contrary to all the existing evidence. This result alone, in retrospect, should have been sufficient to prompt further inquiry on the adequacy of the model specification.

Finally, the limited attempts at forecasting have not been very encouraging. In Hilaire et al (1990), the model was used to generate forecasts for 1987 and 1988. The actual percentage errors are quite large, especially for the second year of the forecast (1988). For example, in 1988, the forecast errors were 47% for the money supply, 26% for the wage rate and 10% for GDP. The differences between the actual and forecasted growth rates are equally large: an actual growth rate in the money supply of 7.9% is forecasted as 33.9%, a contraction of 2.94% in Gross Domestic Production is forecast as a 1.8% growth while a 16.6 % increase in the Budget Balance is forecast as a 6.4% increase. For comparison, the UNDP model of the Jamaican economy forecasts for the growth rates of constant price GDP for the years 1990 to 1991 (the two years adjacent to the historical data used to fit the model) show significant differences between actual and forecast growth rates: a 5.4% actual growth rate was forecasted at 2.5% in 1990 and a 0.5% growth rate in 1991 was forecasted at 2.6%.

The above indicates that the limited forecasting experience of both these models leave a lot to be desired. This questions the practical validity of macroeconometric models in the Caribbean context and whether other kinds of models may not more appropriate. One possible alternative is the "accounting" type models such as the one proposed by Bruce (1987) for the more data deficient countries of the Caribbean and which bears a striking resemblance, at least in spirit, to the Revised Minimum Standard Model of the World Bank (Tims and Waelbroeck (1982), chapter 2). Another alternative is to look in the direction of the more elaborate Computable General Equilibrium (C.G.E.) models which, although not requiring a lengthy time series, presupposes the existence of a recent Social Accounting Matrix which, at the moment, exists in no English speaking Caribbean country.

In summing up the model building experience to date in the Caribbean, it is not unfair to state that all 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 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 working environment. Indeed, by the beginning of the 1990s, the large scale model attempts which had 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 model building 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 emphasised 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[17]. The detailed attempts at forecasting based on macroeconometric modelling slowed in most of the MDC Central Banks, aggravated, in part, by an exodus of econometric specialists[18].

The question which needs to be resolved in light of the experiences with model building is how should the process of constructing cost effective models for forecasting and policy analysis proceed in the various Caribbean Central Banks. We envisage two alternatives:

- a prototype model taking into account the general features of Caribbean type economies but flexible enough, say, to account for varying oil prices in Trinidad and Tobago and varying banana prices in the Winward Islands. The model, once adapted to the circumstances of a particular country, will become a model of that country alone. This is similar in spirit to the model of Worrell and Holder (1987) but may not at all resemble that particular prototype.
- a single model of the region which will take into account individual differences along the lines of "Pooling Data" methods similar to the IMF type models of Haque et al. (1990) and Leon and Samuel (1994).

The first alternative takes into account the similarities as well as the very real differences that exist among the various countries making up the English speaking Caribbean. The second alternative assumes that the similarities are much more noteworthy than the differences, an assumption that was roundly rejected by Watson (1993) in a study involving the OECS countries which, on a priori grounds, would be the most homogenous grouping in the region.

3 Elements of a Successful Forecasting Strategy

In this section we argue that a successful forecasting strategy must be based on a structured forecasting environment. The main elements of that strategy include a structured approach to modelling, a systematic forecasting process, commitment and support across departments and affiliated institutions, and the fostering of a community spirit through a process of dissemination.

As an illustration of the underlying basis for the guidelines, consider the apparently simple question "should an overseas foreign currency deposit be hedged against the risk of currency depreciation?" Stated in presciptive form, those questions invariably relate to a population of interest. The *Yes/No* initial question becomes "What will be the exchange rate during the forthcoming period of interest?", which in turn asks "What are the factors determining the future exchange rate?" By casual observation or logical deduction we hypothesise a conjecture that the exchange rate is a function of a set of variables. What type of function? What set of variables? We require a body of knowledge and an articulation of a transmission mechanism to guide our specification of the function, and adequate data and statistical analysis to confront the conjecture.

3.1 The Forecasting Process

In an ideal environment, the modelling process has well articulated objectives, there is a body of theory to guide the econometrician in formulating models and establishing mappings from theoretical latent constructs to observational equivalences, the data exist for a sufficient long period and with appropriate periodicity for the policy questions of interest, appropriate estimation methods are known and used, adequate diagnostic tests are conducted, inference follows sound statistical procedure and the model is interpretable relative to the questions of interest. But there are technical and institutional constraints that ensure that the ideal conditions do not materialise, thereby producing questionable results. By identifying critical junctures in the process we can note the points at which errors can be introduced into the modelling process; we can therfore seek to reduce those errors by judicious choices where possible. The relevant aspects of an appropriate modelling approach have been detailed in section 1. We can summarise by stating that all models should satisfy certain desirable conditions: be theory consistent; be data coherent; must reflect policy sensitivities, realities and constraints; be capable of accurate historical simulation; and be available for replication of results. It is therefore clear that our needs must include a database that can facilitate, using principles of good model design, individual and comparative analyses of economic processes.

The forecasting process must generate immersion of the relevant constitutents. We will assume without further elaboration that the objectives of the model have been clearly stated and there is a stated commitment to the process by the Central Banks and other relevant institutions. This commitment has to incorporate development, application and refinement time for the model. More importantly, there ought to be a mechanism that integrates the activity maps, resource bases and comparative advantages of various departments of the institution in the development and usage of the model. The model building exercise should not be viewed as the work programme of a sub-group of individuals. The forecasting process must generate a sense of belonging among participants; it must carry the same lofty ideals and generate the same cooperative spirit as exists across all departments in the Central Bank when the Annual Report (say) is being compiled - information flows from all departments in a timely manner, tone and judgement is exercised by management, and the text is edited for accuracy, style and impact. There must be cognisance of the skills base and current work profiles of computer programmers and analysts, investment officers and bank supervisors and how those skills map into actvities that can contribute to and enhance the overall efficiency of the modelling process.

The Central Banks should strive to build quarterly forecasting models with a two to three quarter short horizon and a six to eight quarter long horizon, both of which should be updated as information flows in, bi-monthly for the short and quarterly for the long horizon forecast. Forecasts should be released periodically and a mechanism for updates instituted. Regular updates enhances the accuracy of the final forecast evaluation, ensures the incorporation of revised data and unanticipated events, provides continuity to the modelling and forecasting exercise and utilises available information in an optimal manner. It is more important to incorporate information to refine a forecast than to do a post mortem of a three month old forecast and seek blame. However, care ought to be exercised in ensuring that every "new bit of information" does not change the forecast.

Given the stated goals and tolerance levels for the forecasts, a monitoring process ought to be established and maintained for control purposes. This signalling device is not only informative as a tracking device for the model but may also serve the purpose of monitoring the effects of policy changes or the impact of external impacts. A clear listing of forecast input assumptions and their computational basis (data, judgemental, or anecdotal) is of vital importance in evaluating whether forecast errors are due to factors outside of the control of the forecasters, and helps to develop and maintain the credibility of the forecasts.

Forecasts should be presented in a simple manner with a decided takeaway, must be technically correct and understandable to policy makers. They should indicate alternative scenarios or a probability weighted forecast with relevant interval ranges. Graphical interfaces ought to be developed to facilitate presentation, scenario demonstration, and model linkages. To encourage exchange and adequate dissemination, it maybe necessary to have a common software available at all institutions. Management Information Systems departments should be involved in the development of foreign language interfaces and front end menus.

Since the data collection and publication lags inevitably mean that at any point in time the model is not being solved with current data, a mechanism for constructing imputed data up to the current period (to be subsequently revised) and the incorporation of structured "conjunctural" analysis into forecasts cannot be understated[19]. Where regional forecasts are deemed necessary, it is essential that assumptions on global or extraregional assumptions be common to each individual country models. Again the principle of community involvement and cooperative participation can be extended to embrace all the regional Central Banks and RPMS as a regional institution with stated goals.

3.2 An Integrated Information Architecture

This infrastructure should include the appropriate hardware and communication systems to support the forecasting drive. Collaboration requires the dissemination of data, an institutions skills database, techniques and models among the participating institutions. This would have the obvious benefit of minimising duplication of effort, generate skills enhancement by sharing and ensure greater uniformity of development across the Central Banks. Exchange visits among staff of various departments of the Central Banks should be regularised, and RPMS meetings, mid-year and annual, should be used to share results, analyses and approaches to various problems. In a supplementary role, the RPMS centre in Trinidad and Tobago can serve as a clearing house, disseminating data and providing a hub for comparative research projects. A minimal requirement for integrating the RPMS with the Central Banks would be a network topology that allowed access to the various Central Banks. Even if this stage of network development is not contemplated now, given different stages of networking topologies and current hardware at the various Central Banks, at the very least, a common transfer protocol should be established with individual routines to interface with software at various institutions. This has the attraction of being low cost and allows the growth of institutional interaction before full blown networking.

A well-developed database system must be flexible enough to allow the modelbuilder to manipulate the data items in the most convenient form. Such a system should contain facilities for :

- Performing extensive data exchange on electronic media
- Creating data entry forms with built in verification checks
- Sorting, matching and merging records
- Manipulating data of various periodicities
- Producing reports with text, tables and high resolution graphics in 2D and 3D.

This database system should also allow for easy interfacing with specialized model building packages; in turn, the chosen statistical packages should contain facilities for addressing external libraries and have an inbuilt programming language to allow coding of new developments is estimation and testing.

In addition, efforts to improve the actual data should be intensified: publication lags need to be shortened, the overall scope widened, and the periodicity of the data increased. The problem of the inadequacy of the statistical data base in Trinidad & Tobago in relation to econometric modelling was addressed more than a decade ago by Watson (1984), and the issues raised then were valid for all English speaking Caribbean countries. Today, the "inadequacy gap" has widened.

In the Caribbean, the practice of generating these data is a fairly well established one although things are far from perfect. Some immediate shortcomings, valid for most (and perhaps all) countries are the following:

data in most categories are available at best on an annual basis. This limits the forecasting exercise to annual models; adjustments that take place from quarter to quarter, for instance, cannot be anticipated in order to allow for corrective measures

- inter sector demand (Input/Output) data are totally absent

- there is little or no useful disaggregation in certain key areas like the components of aggregate demand

- constant price information and the corresponding price deflators for the trade sector, for example, import demand and exports of tradeables, are very limited.

- most of the data are published with an appreciable lag. In 1992, for example, the modelling team may be working with data for which a complete set is available only up to 1989. But in 1992, policy makers are interested in forecasts for 1993 and beyond, and not for 1990 to 1992, which is clumsy given the state of the data. Furthermore, for completeness, data compiled at different sources are frequently related to each other by obvious identities but, more often that not, such coherence is absent from the published data either because of different practices of the various agencies preparing the data or because of the timing of the publications.

3.3 Material and Human Resources

There are many (including the most highly trained) professional economists who believe that all that is required for a good model is a competent econometrician able to ply his trade of running regressions and interpreting t-ratios and R^2s. Nothing can be further from the truth and, indeed, the discussion in the previous sections would have already given a hint that the generation of an econometric forecast and, by extension, the maintenance of a macroeconometric model, may require human and material resources that go way beyond this. In fact, it may turn out to be quite expensive[20] ! In as much as a strong commitment is required, institutions should consider the costs and benefits of engaging in a forecasting exercise. Collaboration, as discussed below, can help reduce costs and increase benefits to individual institutions. This section itemises resources needed for an average institution.

The discussion which follows assumes a model of the size and complexity of the ILPES (1986) model (two of the models cited above, the St. Cyr and Charles (1992) model and the UNDP (1991) model of Jamaica, follow this prototype). This is somewhat larger than the other known Caribbean prototype, the Worrell-Holder (1987) model, largely because it is more disaggregated and it takes specific account of the demand side of the economy. Notwithstanding this, it is fairly modest in size (less than 100 equations) and is relatively highly aggregated; therefore, it is not far fetched to assume the size of the ILPES model as an approximate minimum requirement for a typical Caribbean model.

In general, the modelling and forecasting exercise depends on third parties like the Central Statistical Office and the Central Bank to generate most of the data to be used. These include data on national income, prices and wages, balance of payments, stock of money and domestic credit and government's fiscal operations. Given the data deficiencies stated above, it might be asking too much to have all these various agencies, and sometimes even the sub units within an agency, to so radically alter their practices to suit the modelling unit, even though the latter may be part of the state sector to which the data collecting agencies belong. We believe that it is imperative for the modelling unit to have the services of at least one competent and trained statistician whose principal task would be to acquire an almost perfect knowledge of data collection and compilation practices and data sources in the country or countries concerned. To him/her will fall the (full-time) task of liasing with the various data collection agencies, of filling the inevitable gaps in the data so as to bring the data base up to date, of initiating the compilation of new series, and of marshalling the existing data into a coherent whole (so that, for example, identities required by economic theory are respected). The ideal person would be computer competent (and not simply literate) and should be able to make recommendations about data entry, storage and retrieval in a computer environment.

The statistician should also be a pioneer and be able to use his/her privileged relationship with the data collection agencies to obtain data to satisfy the demands of an ever increasingly sophisticated model. One immediate area in which this is possible is in the construction of an Input/Output table and, eventually, a Social Accounting Matrix (SAM). A major concern of Caribbean economists is the "demand management" emphasis of macroeconometric models and the consequent inability of these models to forecast supply bottlenecks (Boamah (1981)). With the increasing emphasis on "structural adjustment" and "economic dependence" in Caribbean countries, inter-industry linkages are going to become more and more important and so too therefore must input-output models. These can be used in conjunction with standard econometric models as outlined in Klein (1980).

A successful modelling and forecasting effort requires the (almost) full time attention of a team of very skilled economists headed by a Chief Economist whose forte should be Economic Theory, more specifically Caribbean Economic Theory. The ideal person should have a thorough understanding of the Caribbean reality (including institutions and structures) and should be fully steeped in the knowledge of recent Caribbean economic history. Knowledge of modern and traditional econometric practice would be an asset but it should be more optional than absolutely necessary.

The Chief Economist would lead a team of sector specialists, each with a thorough knowledge of that branch of economics relating to the sector, for example, a monetary economist would have responsibility for the monetary sector. It is absolutely necessary for such economists to be thoroughly familiar with published economic statistics, especially as it pertains to the data directly related to their specialisation. Once again, a sound knowledge of econometric practice would be useful. The Chief Economist would have to ensure the unit works as a team, engages in an econometric methodology that is "model -wide consistent" and undertakes inter-sector dialogue.

One of the chief responsibilities of the sector specialist would be the specification (and estimation) of equations purporting to explain the workings of the sector under his/her purview, as well as the identification and the modelling of the linkages with other sectors. The Chief Economist would be responsible for co-ordinating the overall modelling effort and for ensuring that the linkages between the various sectors are theoretically and technically sound.

It is this team, together with the statistician, which would be responsible for formulating the assumptions about the future path of the exogenous variables in the model and to analyse the main consequences of the forecasted scenarios.

The modelling effort, of course, requires the services of an econometrician whose principal intervention would be at the stages of estimation and validation of the model. At the same time, he/she must work closely with the team of economists in the specification exercise and must be in close contact with the statistician in working out the data requirements of the model. The econometrician would also be required to keep au courant with current econometric practice; a specifically important duty would be to train (and retrain, if necessary) the economists on the team in the relevant econometric and mathematical methods necessary for the modelling exercise. Whereas he/she must be more concerned with the mathematical properties of the model (such as its stability), there must also be concern about the economic meaning of the coefficients obtained from the estimation exercise, especially if it involves complicated lag structures like those associated with VAR-Error Correction models. Here, too, he will rely heavily on the inputs from the team of economists.

It goes without saying, then, that the econometrician must have a relatively sound knowledge of the underlying economics of the model. Another necessary requirement would be a comprehensive knowledge of state-of-the-art software packages used for estimation and model solution and, ideally, should be able to programme in packages like AREMOS, EVIEWS, GAUSS and RATS and TROLL.

The team of economists should be complemented with a Computer Specialist. The person sought here is a relatively rare breed in the Caribbean today; he/she will be an economist who is at the same time an expert programmer/analyst (perhaps someone with a good first degree in economics with a post graduate training in computer science). In addition to ensuring the required level of computer competence of the other members of the team, this person would be principally responsible for all major programming exercises, including a user friendly interface for use by the economists whose task it will be to generate the forecasts. He/she must also have or be able to acquire specialist knowledge in hardware and software (including spreadsheets, databases and graphics presentation) and be particularly adept in modern methods of data communication using local and wide area networks.

The technical competence of the team would be incomplete without the services of two or three junior economists who, in addition to serving as apprentices, would be required to function as research assistants to the senior technical personnel. They must of course have a sound training in economics and quantitative methods (including economic statistics and econometrics) and be computer literate.

It is unlikely that each Central Bank would be able to devote the required resources to the modelling exercise. Our suggestion would be to house such a team at the RPMS centre. The first task of the team would be the construction of a new prototype model (which will clearly be influenced by the existing ones) which can be easily adapted for specific use by individual countries. Modelling units at the Central Banks would collaborate with the centre, maintain an in-house version of their country and assist in its development. The construction of an adequate data base can be a concurrent activity, eventually feeding into the estimation, validation and forecasting stages for the various countries.

A sustained generation of good forecasts, then, requires the ongoing commitment of a critical minimum level of resources. The need for properly qualified "counterparts" at the Central Banks with almost total modelling responsibilities cannot be understated. The designated users of any model - those who must generate the forecasts - have to play an important part in its construction and development.

4 Conclusion

This paper has explored the requirements for a successful forecasting effort in the Caribbean. We recommend the need for institutional commitment to the modelling effort, an integrated resource approach both within institutional departments and across regional institutions, and a more concerted effort on developing data and systems architectures. We argue for a structured approach to modelling, and for a forecasting environment that fosters collaboration of effort and dissemination of results and skills.

The achievement of a relatively successful forecasting system in CARICOM hinges on the expert blending of sound judgement, economic theory and a sohisticated information architecture with a systematic approach to modelbuilding. These requirements, however, are neither necessary nor sufficient to guarantee the occurrence of "accurate forecasts". 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 model builders are able to anticipate the magnitude and direction of movements in economic variables.

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. The many models that have been constructed have either not been used consistently and, when they have been used, it has not been with any great amount of success. It is quite likely that this is fundamentally the result of a miscalculation of the resources required to produce good forecasts on an ongoing basis; this would explain both the inadequacy of the models themselves as well the lack of use to which they were put.

It is our opinion that current models should be as simple as possible, although the simplicity assumption should never be taken as a license to strip a model of theory-derived complexities simply to facilitate estimation. The simplicity argument stems from the current shortage of adequate data and of a comprehensive macroeconomic theory of Caribbean economies. However, because of the small samples and the omission of potentially important variables, policy recommendations should be cautious and should attempt to quantify the trade-offs facing the decision makers In most cases, structured judgement and experience cannot be ignored or understated

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NOTES

[1] This model is discussed in detail in Friehuis, Fase and Den Hartog (1988)).

[2] See Bodkin, Klein and Marwah (1991) for a detailed description of the history of macroeconometric model building.

[3] This is a compiled version of Craigwell and Walker (1995), Leon (1995), Nicholls and Christopher-Nicholls (1995) and Watson (1995).

[4] The main problem is how to specify the hooks between regional decision variables and national policy parameters. The works of Baird (1983), Bolton ((1980a,b), (1991)), Issaev et al (1982), Courbis (1979) and Milne et al (1980) may offer useful insights to Caribbean modellers. The standard approach is to build a regional system which includes the national models 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.

[5] The early literature postulates that exogenous variables are predetermined, independent of the error terms in the model.

[6] The structural form of a model maybe regarded as a theoretical explantion or hypothesis about the determination of the endogenous variables, conditional on values currently assumed by the exogenous or predetermined. The reduced form of the model expresses a current endogenous variable as a function only of the exogenous and predetermined variables. Structural and reduced form parameters are derived from the estimated models.

[7] For exactly identified models all single equation estimates are the same, that is, Instrumental Variables (IV), Two Stage Least Squares (2SLS) and Limited Information Maximum Likelihood (LIML). For overidentified models, the result depends on theoretical restrictions like the normalisation rule adopted.

[8] This methodology emphasises the notion of parsimony in the construction of models.

[9] A choice of model may not be straigtforward since a model's forecast ranking may not be uniform over different forecast horizons.

[10] It is helpful to remember the three golden rules of econometric modelling, that is, "test, test and test" (Hendry (1980)).

[11] In contrast, for an optimal control exercise, the model is solved for the values of the policy variables (instruments) that will maximise a specified objective function (formulated as a function of policy targets). Typically, a quadratic function is employed with a set of weights that reflect the preferences of the model user.

[12] Best and Levitt (1969) developed a detailed input-output model for the Caribbean but it was never implemented because of the extensive data requirements.

[13] A recent model by Craigwell, Haynes, Walker and Worrell (1993) attempts to combine statistical and judgemental models.

[14] Recent developments in econometric practice post-date the earlier studies.

[15] Applications of this methodology in the Caribbean have been mainly in the single equation context (see Craigwell (1991) and Downes, Holder and Leon (1990)).

[16] In the paper, *BUD* is defined as the Budget Balance but it is really the Central Government's Borrowing requirement (with the sign reversed).

[17] Leon (1990) and Downes, Holder and Leon (1990) popularised this notion in the Caribbean but were unable to explicitly encourage the use of the methodology for policy analysis and forecasting.

[18] For example, work on CBMOD1 stopped at the Central Bank of Trinidad and Tobago after the model group was disbanded.

[19] Bayesian methods may be explored as a means of generating the imputed data.

[20] An unwillingness or inability to provide the resources required is a probable reason for the marked absence of forecasts in the region.

6MACROECONOMETRIC MODELS IN THE CARIBBEAN

JAMAICA

Authors	Purpose and Type	Nature	Estimation	Results	Critique
Carter (1970)	to assess the impact of government fiscal and monetary policies and to make conditional predictions of values of the main macroeconomic aggregates	3 blocks 22 behavioral equations 11 identities	1959-1966 annual data OLS and IV	Data appears to do fairly well in simulation exercises	No estimation of the labour or financial markets
Harris (1971)	The projection of the future resource requirements of the economy in terms of potential export-import and saving-investment gaps	3 blocks 42 behavioral eq'ns 15 identities	1950-1965 Annual data OLS	The trade gap is likely to be more a dominant constraint on growth. Estimation results indicate a good fit and the correlation between observed and predicted values are greater than 0.9.	Neglects the monetary sector Ignores how foreign exchange gap is financed. No use of simultaneous equation estimation techniques.
Manhertz (1971)	To create a prototype of the economic structure. To observe the multiplier effects and results of policy alternatives.	5 blocks 24 behavioral eq'ns 18 identities	1959-1966 Annual data OLS and 2SLS	With the exception of consumption the data tracks fairly well with R squared values ranging from 0.8 to 0.99	Failed to discuss the quantitative aspects of his study and how model could be used to observe the various multiplier effects
Taylor (1972)	Investigates whether a 'real' or monetary mechanism operates in Caribbean type economies.	monetary model: 3 blocks, 4 behavioral eq'ns and 4 identities. real model: 3 blocks, 5 behavioral eq'ns and 5 identities.	1950-1970 annual OLS	Either a monetary or 'real' model is capable of explaining income variations in Jamaica.	The 'real' model failed to consider employment and monetary sectors. No use of simultaneous estimation models.
Worrell (1979)	Unearthing the monetary implications of Linder's (1967) trade model and investigating the existence and stability of the money demand function.	3 blocks 6 behavioral eq'ns 6 identities	1962-1971 Annual 2SLS	The Linder model holds in Jamaica and the money demand function is stable	No consideration of the government and labour markets

Authors	Purpose and Type	Nature	Estimation	Results	Critique
Worrell and Holder (1984)	To analyse economic reactions to changes in international trade and financial markets and official policies	5 blocks 12 behavioral eq'ns 6 identities	1960-1982 Annual 2SLS	with the exception of the nontradable output and deposits the data tracked fairly well with R squared values between 0.6 and 0.99. Results also indicate that government deficits impact on real output and that monetary policy is irrelevant.	largely static model
UNDP (1991)	to develop a model geared to producing forecasts of the Jamaican economy	4 blocks 9 behavioral eq'ns 104 identities	OLS	model fits data well but the forecasts give large errors	No consideration of the monetary block

MACROECONOMECTRIC MODELS IN THE CARIBBEAN

TRINIDAD & TOBAGO

Authors	Purpose and Type	Nature	Estimation	Results	Critique
Brewster (1972)	Investigates the relationships between employment and a number of economic variables in an export biassed underdeveloped country so as to later develop a simultaneous equation model.	3 blocks 39 behavioral eq'ns	1951-1968 annual OLS	Research suggests that domestic sector development i.e. changes in wages, consumption and domestic output are important to the formulation of the hypothesis on the growth of employment .	No consideration of other economic blocks e.g government
Persaud (1975)	To develop a quantitative description of the Trinidad and Tobago economy so as to visualise the likely effects of anticipated monetary and fiscal policies and to project economic growth	2 blocks 11 behavioral eq'ns 4 identities	1960-1971 annual OLS & 2SLS	Most of the data tracks well (R squared values greater than 0.8) and the predictive power is adequate.	No discussion of monetary nor employment sectors.

Authors	Purpose and Type	Nature	Estimation	Results	Critique
Gafar (1977)	attempt to construct a simple model of the Trinidad economy	5 blocks 38 behavioral eq'ns	1951-1968 annual OLS	The model represents a satisfactory prototype (the R squared values were generally above 0.95)	No use of 2SLS which may be a more appropriate tool of estimating simultaneous equations models.
St Cyr (1978)	To analyse the responsiveness of policy variables on key macroeconomic variables using an export propelled model	3 blocks 6 behavioral eq'ns 8 identities	1965-1976 Annual OLS	there is no clear indication as to whether domestic wage cost and prices impinge on the Balance of Payments	No consideration of labour and government sectors OLS is not the appropriate tool for modelling nonrecursive systems.
Joefield-Napier (1979)	attempts to explain aggregate demand	6 blocks 8 behavioral eq'ns 3 identities	1970-1978 Quarterly OLS	no policy implications	supply side omitted. No use of simultaneous equations techniques.
Worrell and Holder (1984)	as above for Jamaica	as above for Jamaica	as above for Jamaica	as above for Jamaica	as above for Jamaica
Charles (1989)	to understand a country's critical relationships and interdependencies through quantitative analysis. Use (a) modified ILPES model and (b) export driven model	model (a) 5 blocks 22 behavioral eq'ns 15 identities model (b) 3 blocks 6 behavioral eq'ns 3 identities	1966-1985 annual OLS	a)most equations recorded R squared values above 0.9 b)all estimates were over 0.96. Adequate simulation results	No use of simultaneous equation estimation methods.
Hilaire, Nicholls and Henry (1990)	examines implications of policy and nonpolicy shocks as well as to develop a forecasting model	5 blocks 17 behavioral eq'ns 17 identities	1966-1986 annual 2SLS	some results contained large forecasting errors	Suffers from use of current versus constant period values Some of the behavioral equations could be identities

Authors	Purpose and Type	Nature	Estimation	Results	Critique
St. Cyr and Charles (1992)	To analyse the responsiveness of policy variables on key macroeconomic variables using a) modified ILPES model and b) an export propelled model	a)5 blocks 22 behavioral eq'ns 15 identities b) 3 blocks 6 behavioral eq'ns 3 identities	1965-1985 annual OLS & 2SLS	both models coefficients were significant and had good tracking ability. Therefore the authors are neutral in choosing the better model	the export propelled model failed to consider the financial market
Clarke and Watson (1992)					

MACROECONOMECTRIC MODELS IN THE CARIBBEAN

GUYANA

Authors	Purpose and Type	Nature	Estimation	Results	Critique
Jarvis (1990)	to quantify the relationships which govern fluctuations in the Guyanese economy and to present such quantifications in an economic model	4 blocks 12 behavioral eq'ns 5 identities	1957-1976 annual OLS & 2SLS	data explains adequately as it outperforms the naive model	Neglect of monetary and employment sectors.
Ganga (1990)	to explain the behavior of key macroeconomic variables and the effects of various policies on them	5 blocks 7 behavioral eq'ns 10 identities	1966-1985 annual 2SLS	good tracking and forecasting results. Policy simulations suggest that tight fiscal and monetary policies and exchange devaluation are inimical to growth and ineffective in correcting internal and external imbalances	No consideration of employment block

MACROECONOMECTRIC MODELS IN THE CARIBBEAN OECS					
Authors	**Purpose and Type**	**Nature**	**Estimation**	**Results**	**Critique**
Leon & Samuel (1993)	to analyse past economic changes in the St. Lucian economy. To explore sensitivity to external shocks and to assist policy makers in forecasting and policy formulation.	5 blocks 16 behavioral eq'ns 39 identities	1977-1992 annual OLS	results from both the short run and long run equations were encouraging. The signs of ECM terms were negative and less than 2. The t statistics suggest that there are significant short term variations around long run trends	Use of OLS might not have been the most appropriate tool. Little discussion of simulation results.

MACROECONOMECTRIC MODELS IN THE CARIBBEAN BARBADOS					
Authors	**Purpose and Type**	**Nature**	**Estimation**	**Results**	**Critique**
McClean(1979)			no estimation performed		
Worrell and L. Holder (1979)	Attempts to describe the economy using a monetary model and, to more importantly, explore central bank policy and its effects.	4 blocks 5 behavioral eq'ns 5 identities	1946-1978 annual 2SLS	The estimations were statistically acceptable, however some of the simulations did not track very well	Little dynamics

Authors	**Purpose and Type**	**Nature**	**Estimation**	**Results**	**Critique**
Boamah (1982)	An attempt to specify an operational model for Barbados.	5 blocks 41 behavioral eq'ns 21 identities	No estimation performed	No estimation performed	It has been realised that the interrelationship between real and financial sectors is complex and the effect of certain monetary transmissions is uncertain.
Worrell and C. Holder (1984)	as above for Jamaica	as above for Jamaica	as above for Jamaica	as above for Jamaica	as above for Jamaica
McClean (1985)			no estimation performed	no estimation performed	
Boamah et al (1985)	to analyse the working of the Barbadian economy and to provide forecasts for the medium term	4 blocks 8 behavioral eq'ns 4 identities	1969-1982 annual OLS & 2SLS	good explanatory power however forecasts are poor	no inclusion of government
Worrell and Galawish (1988)	Combines econometric and accounting framework to analyse the workings of the Barbadian economy	5 blocks 5 behavioral eq'ns 8 identities	1958-1986 annual OLS	equations fit well but projections were somewhat unrealistic	No use of 2SLS . Static model.
Craigwell, et al (1993)	An extension of Galawish and Worrell	5 blocks	1965-1992 OLS annual	although equations performed adequately, the tracking ability was poor.	Did not use 2SLS
Anyadike Danes (1994)	framework for assessing the macroeconomic policy options and generate projections for important economic indicators	4 blocks 7 behavioral eq'ns 7 identities	1965-1992 OLS Annual	data tracked well. Results suggest that fiscal policy instruments have more permanent effect on the level of national income	Model ignores the supply side of the model.

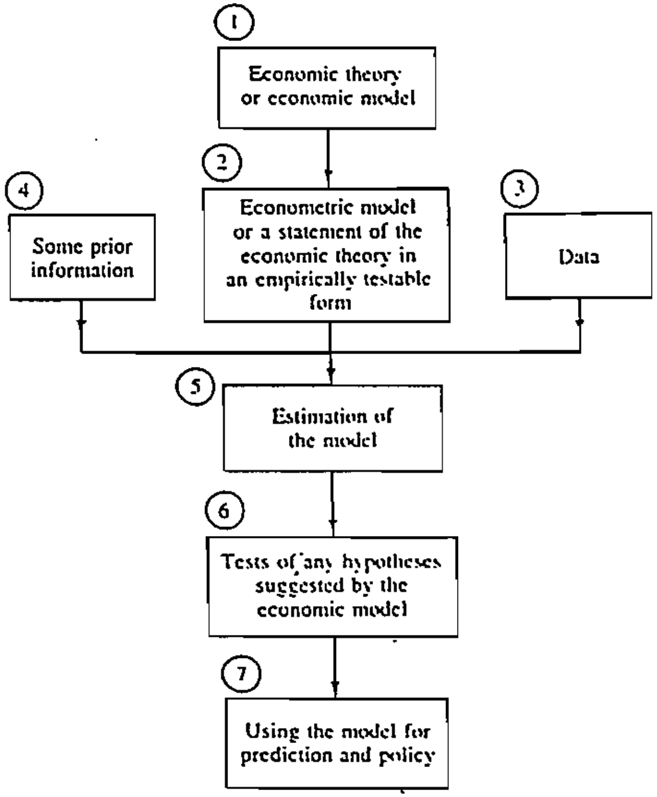

Figure 1.1. Schematic description of the steps involved in an econometric analysis of economic models.

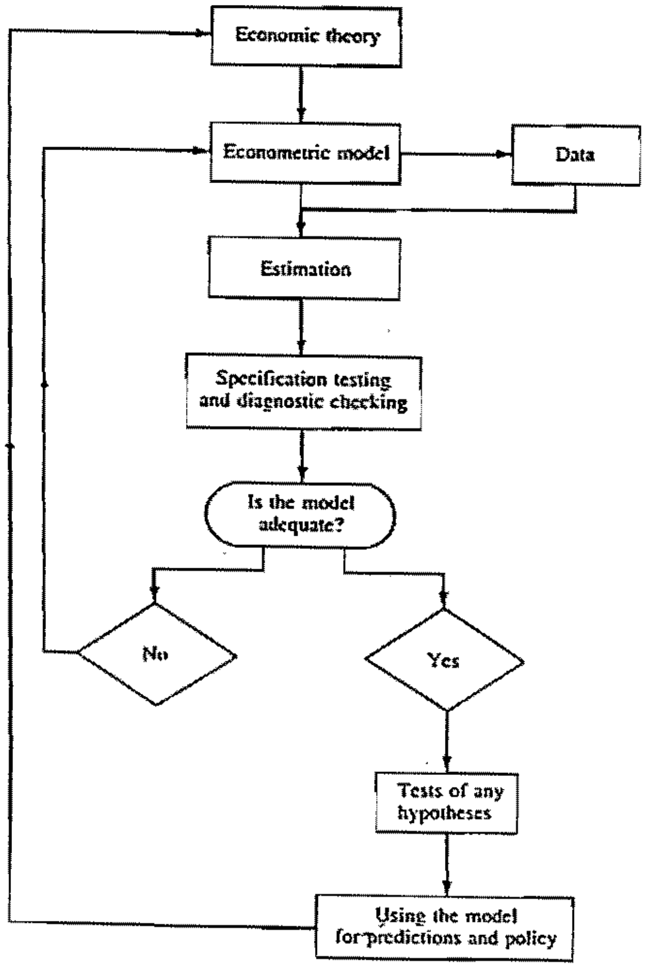

Figure 1.2. Revised schematic description of the steps involved in an econometric analysis of economic models.