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A Literature Survey of Macro Econometric and CGE Models in Sri Lanka



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The Micro Impacts of Macroeconomic and Adjustment Policies **(MIMAP)** program is an initiative of the IDRC, Canada with projects currently operational in several Asian and African countries. MIMAP is based on the idea that macroeconomic policies need to be guided by the final outcomes at the micro level. Hence, MIMAP program initiatives seek to increase the understanding of the links between macroeconomic policies and household income and wealth; and the 'feedback loop' that alters the efficacy of the original policy and its design.

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1. Introduction

Macro economic adjustment policies have been adopted by many developing countries during the last two decades or so. The main objectives of these macro economic policies are long-term change in economic structure and rapid growth in the economy. Most of the countries that adopted this strategy have achieved structural changes in the economy from agriculture to industry and service orientation and rapid economic growth. Impact of these macro economic policy changes on low-income households were not considered as a main issue. However, the majority of households in all developing countries belong to low income groups. Generally, policy makers stated or assumed that these low-income groups would benefit gradually after trickle-down of the fruits of economic development over time. But most of the country experiences are unable to prove this Kuznets' "inverted U" hypothesis. In the short and medium term, adjustment policies are double edged: favourably affecting growth but unfavourably affecting poverty, inequality, marginalization and social exclusion.

The concept of Micro Impact of Macro Adjustment Policy (MIMAP) project is built around this dilemma on multi-disciplinary perspective. MIMAP approaches this issue from an information providing and knowledge enhancing angle, focussing on the impact of macro adjustment policies on the well being of low income households and small-scale firms. This type of project is necessary for policy makers to understand the links between macro adjustment policies and their micro impact and transmission mechanism of growth among the different income and social groups.

2. Main Objectives of the Study

The main objectives of the study comprise the following:

1) Catalogue some of the macro econometric and Computable General Equilibrium Models (CGEM/CGE) developed for the Sri Lankan economy during the last 20 years. Tabulate details such as type of model, the organization or individual responsible for its development, the time period, present status and so on.

2) Detailed review of models chosen on the basis of their relevance to the objectives of the MIMAP project. This includes summary of the model, methodology, its development, objectives of model development, strengths and weaknesses with respect to systems, dynamics and expectations of the model, usage and policy implications of the model.

3) Review some of the CGEM developed by the Asian countries to ascertain their relevance to the Sri Lankan MIMAP project.

4) Recommend the existing econometric/CGE models that would be further developed to meet the MIMAP objectives and give guidelines for future modelling exercise of MIMAP.

3. Organization of the Study

After a brief introduction into macro econometric models in developing countries, this report catalogues the macro econometric models developed in Sri Lanka during the last 20 years or so. The second part of this report catalogues CGEMs developed in Sri Lanka during the last two decades. Third part of this report reviews some of these models which are relevant to the objectives of Sri Lankan MIMAP. The fourth part reviews the model developed in Asian countries which are directly relevant to MIMAP. The final part of this report presents the selected models which are directly applicable to the Sri Lankan MIMAP project and gives policy recommendations and guidelines in building macro econometric/CGE models inline with the objectives of the MIMAP.

4. Macro Econometric Models in Developing Countries

Macro econometric models in developing countries were initiated in the 1930s and they came to be popular in the fifties and early sixties. Initial contributions were made by Harrod (1939) and Domar (1946). These two models were useful in focussing the issues such as savings, investment and desired economic growth in developing countries. These models turned into two gap models under the influence of Chenery (1966), Mckinnon (1966) and others in 1970s. During the eighties they were further extended and revised within the framework of computable general equilibrium framework under the direct influence of the structuralist school. A different type of accounting model was introduced by the IMF. These models consist of a large number of accounting identities and few behavioural equations which can be used to analyse the short-run policy problems and assess the magnitude of the alternative policy options. These models integrated with the flow of fund analysis in order to establish linkages between real and financial sectors and examine the implication of budgetary deficits, interest rates, devaluation and short-term economic stabilization.

Generally, macro econometric models can be classified into various categories such as Keynes-Klein (KK), Phillips – Bergstron (PB), Walras – Johansen (WJ), Walras – Leontief (WL) and Muth-Sargent (MS). However, in broad terms these models can be classified as:

1) Chenery and Strout two gap models
2) Harrod - Domar aggregate growth models
3) Monetarist models
4) Links models

Two gap models were widely used during the 1960s to calculate the foreign exchange requirements for LDCs to achieve different growth rates. These models simply ignore the simultaneous income determination process through the demand and supply factors and place more emphasis on economic growth as a more important objective. The WL models are a sub-group of the family of general equilibrium models of type WJ. A WL model is largely based on the output matrix of the economy emphasis on supply side of the economy. Links models integrate country models with the world economy. These models are suitable to analyse regional and global trade issues.

Among the models built in developed countries, the KK models occupy a dominant position. The KK models are mainly based on the Keynesian theory of effective demand which may be not the fundamental problem in most LDCs. But most analysts have pointed out that the most appropriate models for LDCs are supply side models. The emphasis on supply side is important since, in LDCs, supply is slow to adapt to changing demand and limited in its ability to expand production in the long run. It seems that, in econometric models for the LDCs, supply should be emphasized somewhat more than in the models built for the developed economies, since even though effective demand may be one of the factors limiting output in some sectors, in general the inadequate availability of production factors is the major constraint upon output expansion in these economies. A more useful approach, therefore, should be to consider each sector of the economy separately. In most LDCs agriculture plays a very important role and it comprises several commodities. Therefore, sub models can be built considering their supply, demand and price determination mechanism. The manufacturing sector also has various structural features such as supply constraints and technology and capital limitations. Therefore, modelling of this sector should capture these special characteristics.

The task of modelling the financial sector is more challenging after the implementation of financial and banking deregulation in most LDCs. Especially, financial deregulation has changed the channels of demand and supply of financial resources. These aspects should be incorporated into the modelling excerise. The external sector also plays an important role in most LDCs. Import and export functions should be included in the model by considering their demand and supply situation. In modelling the government sector, its revenue should be disaggregated to reflect the features of the existing tax system and its weaknesses. Most of the changes occurred during the globalization era especially liberalization of the economy by removal of restrictions on trade and foreign exchange, privatization of public enterprises and reformation of the financial sector. These changes can be captured through CGEM. This is a further advancement in macro econometric modelling .

5. Macro Econometric Models Developed in Sri Lanka During the Last 20 Years

Macro econometric modelling grew rapidly in importance during the late 1950s and 1960s and continued to achieve a very influential role in macro economic policy formulation in the 1970s in Sri Lanka. During the 1980s and 1990s, macro econometric modelling was criticised due to their failure to deliver well promised economic controls all over the world. This criticism was mainly based on systems, expectations and dynamics of the models in developing countries. Most of the macro econometric models developed in Sri Lanka during the last few decades cannot be used for forecasting or policy formulation because of non-availability of qualifiable data, specialists, advanced estimation techniques, financial support and other equipment. Most of the early Sri Lankan models were part of the author's study dissertations or thesis. Institutional support for model building is very minimum in Sri Lanka. So far, there are very few major modelling exercises published by government institutions or policy making bodies in Sri Lanka.

Most of the econometric work in the post independent and pre-liberalization era was done at designing development plans by the government agency responsible for economic planning. Most of these development plans were public sector expenditure programs. The 1959-69 Ten Year Plan and the 1970 Five Year Plan used some econometric techniques. The public investment

programme (Rolling Plan) which began in 1979 normally use spread-sheet analysis for the forecasting activities.

Table1 below shows the macro econometric models available in Sri Lanka. The striking feature of this Table is the lack of institutional support for model building in Sri Lanka. Some of the models developed by government departments and policy-making bodies were not available in published form due to unknown reasons. All the models listed here, except two, used annual data for their estimation. This is mainly due to lack of quarterly national accounting data for Sri Lanka. Wijesinghe (1989) and Jayamaha (1989) used generated quarterly data from the annual observation for estimation of their models. Most of the authors used OLS or 2SLS estimation techniques to estimate the model depending on the simultaneous nature of the model. The aggregate nature of the models can be measured by the number of equations and the number of identities of the model. Most of the early models were highly aggregated in nature. Models developed by Cooray, Karunasena, Perera and Rankaduwa contain the most number of equations and identities.

Table 1: Econometric Models available in Sri Lanka

Model	Period	Types of Data	Estimation Methods	Number of Equations and Identities
ECAFE(1968)	1956-1966	Annual	OLS	18 and 8
Dahanayaka (1977)	1960-1972	Annual	2SLS	13 and 7
Weerahandhi (1979)	1970-1979	Annual	OLS	7 and 1
SLECON (1981)	1959-1979	Annual	2SLS	7 and 5
Perera(1984)	1970-1982	Annual	OLS	15 and 9
Karunasena (1986)	1950-1980	Annual	2SLS	35 and 54
Athukorala & Huynh(1987)	1959-1977	Annual	OLS & 2SLS	12 and 14
Wijesinghe (1989)	1974-1982	Quarterly	OLS	4 and 9
Jayamaha (1989)	1977-1985	Quarterly	2SLS	8 and 6
Colombage (1991)	1960-1986	Annual	OLS	10 and15
Cooray(1992)	1970-1990	Annual	OLS	17 and 10
Perera(1994)	1960-1989	Annual	OLS and 2SLS	75 and 72
Rankaduwa (1995)	1960-1987	Annual	OLS	43 and 17
Cooray(1996)	1970-1990	Annual	OLS	68 and 64
Cooray (1998)	1970-1996	Annual	OLS	16 and 9

In addition to these models, a number of macro econometric models can be found in Sri Lankan Universities, the Central Bank and other Research Organizations. These models are mainly students' or employees' research papers or unpublished theses. Meguid (1967) developed a programming model which can be used for short-term programming activities. Gafoor and Kooyman (1980) developed a Keynesian type of aggregate demand model. This model did not consider the supply side and constraints. In addition to these macro models, links models were also built to capture some issues related to regional integration and trade. Most of these models may not be complete and are highly academic in nature. These models will be documented in the latter stage of this MIMAP project. Table 2 provides information on the structure of the models developed in Sri Lanka.

Table 2: Structure of Models

Model	Structure of the Model
ECAFE (1968)	Two gap model
Dahanayaka (1977)	Two gap model
Weerahandi et.al (1978)	KK model
SLECON (1981)	KK model
Perera (1984)	KK model
Karunadasa (1986)	KK model with supply constraints in the economy
Athukorale and Huynh (1987)	KK model
Wijesinghe (1989)	Monetary model
Jayamaha (1989)	Monetary model
Colombage (1991)	Monetary model
Cooray (1992)	Monetary model
Perera (1994)	KK model with supply constraints in the economy
Rankaduwa (1995)	KK model
Cooray (1996)	KK model with supply constraints in the economy
Cooray (1998)	KK model

As this table illustrates, noticeable improvements have been achieved in macro economic modelling in Sri Lanka. Especially various two gap models, KK models incorporating supply-side and monetary models have been constructed over time. Models developed by Cooray, Karunasena and Perera included the agricultural sector which is divided into sub models emphasising the different structures of each subsector. The monetary sector was also subject to

modelling under the structural adjustment facility arrangement. Models already listed above have been applied for the following policy purposes in Sri Lanka.

1. ECAFE (1968) model has been used for the projection of savings and investment gaps in Sri Lanka.
2. Dahanayaka (1977) model has been used for the projection of foreign exchange requirements under the different policies.
3. Model developed by Weerahandi et.al (1978) does not have policy simulation.
4. SLECON (1981) model does not have policy simulation.
5. Perera (1984) model has been used for forecasting the external debt problem.
6. Karunasena (1986) model has been used for conditional forecasting and evaluation of the impact of increase in different components of government budget, and increase in foreign grants and loans and evaluation of short run impact of changes in rainfall.
7. Athukorala and Huynh (1987) model has been used to analyse the impact of fluctuations of export earnings on the economy.
8. Wijesinghe (1989) model has been used to analyse the impact of export and import price shocks and to investigate the alternative monetary policy responses.
9. Jayamaha (1989) model has been used for simulations to assess the relative impact of various monetary policy instruments on the economy.
10. Colombage (1991) model has been used for evaluation of factors that affect the balance of payments.
11. Cooray (1992) model has been used for the analysis and evaluation of the monetary, fiscal and exchange rate policies in individual balance of payments accounts.
12. Perera (1994) model has been used to show effectiveness of fiscal, monetary and agricultural policy. This model has been used for many other policy purposes such as evaluation of the impact of external and internal shocks, and different policy responses on the economy, and the evaluation of long run impact of fluctuations in world commodity prices on the Sri Lankan economy.
13. Rankaduwa (1995) model has been used for simulation experiments of exchange rate devaluation, terms of trade deterioration, monetary policy shocks, world income growth and world inflation.
14. Cooray (1996) model has been used for simulation of effectiveness of the exchange rate devaluation, increase in government investment expenditure and pricing policy. This model was further used to evaluate the impact of increase in world demand for tea, increase in world GDP and reduction in world supply of tea. The most interesting feature of this model is that it tries to endogenise population and employment through the production sector.
15. Cooray (1998) model has been used to analyse the impact of government policy changes on the agricultural sector.

As these show, there is a marked improvement in the use of models from the two-gap projection to the different policy analysis. Sri Lankan experience of macro econometric modelling provides

valuable lessons to most LDCs because the characteristics of the Sri Lankan economy are similar to those of most LDCs.

6. Computable General Equilibrium Models in Sri Lanka

The recent popularity of CGEM approach in Sri Lanka was due to the shortcomings of the partial equilibrium approach to macro economic policy formulation. The main aim of CGE approach is to convert the Walrasian general equilibrium structure from an abstract representation of an economy into realistic models of actual economies. The first application of CGE model to the Sri Lankan economy dates back to the mid seventies (de Melo, 1978), even though its application did not spread into wider policy areas due to many reasons (Bandara, 1989, 1991).

The interest in multisectoral modelling came in Sri Lanka in 1970 after the compilation of input-output table for the year 1968 (UNDP/SF, 1970). Using this input-output table three researchers have attempted to build models. First is a multisectoral input-output model (Narapalasingham, 1970), second is a ten sector linear programming model (Jayawaradane, 1970) and the third is an agriculture sector based linear programming model (Sirisena, 1976). The main motive behind an upsurge of multisectoral optimization models in mid 70s and 80s was the construction of Socio Accounting Matrix (SAM) which gave a very good data base for modelling culture in Sri Lanka (Pyatt et.al, 1977). Among these, ten sector optimization models which were built to investigate the impact of different development strategies on the sectoral resource allocation of the economy (Anandalingam, 1983) and multi-sectoral inter-temporal optimization model to study the optimal development path for Sri Lanka (Wijesinghe, 1986, ibid) are the most important models. From the mid seventies, a number of CGE models have been constructed for the Sri Lankan economy by various researchers and organizations.

As stated earlier, de Melo (1978) was the first researcher to build a CGE model for Sri Lanka. The main data base of this model is the SAM. The theoretical structure of this model is based on the World Bank CGEM static structure (initiated by Adelman and Robinson, 1978 and Dervis et.al, 1982). This static model can be updated over time through a set of inter-temporal linkages to capture dynamic aspects of the economy. Profit and utility maximization by consumers and

producers is assumed. Seven production sectors and their output level is specified in two levels which the CES production function is specified with substitution possibilities in each production level. At first level, fixed and variable factors were aggregated separately and at second level, sectoral output was expressed as a function of the aggregate fixed factors and aggregate variable factors. Unskilled labour concerns are treated as variable factors and skilled labour, land and capital concerns as sector-specific factors. Skilled labour can be mobile across the sectors which mainly relate to the dynamic part of the model. Households were grouped into six categories and their incomes were determined through a factor ownership matrix. Demand for households was estimated through a spliced linear expenditure system. The role of government was introduced into the model using various taxes and constant sectoral expenditure shares. The dynamic nature of the model is specified through the growth of population, capital stocks and household mobility among the various socio-economic groups. The **policy experiments** of this model were carried out by running the model over a ten year period for fifteen macro aggregate variables. In different stages, this model has been used to examine the effects of selected agricultural policies, alternative development strategies and alternative approaches to basic human needs.

The main limitations of this model are:

i. it can be used only for very specific applications;
ii. there is no easy access for up-datement or modification;
iii. the theoretical specification and estimation method imposes limitations on its use for other policy issues;
iv. there are limitations in scope for the analysis of trade policy issues;
v. there is a lack of adequate treatment of some important economic variables;
vi. it cannot consider sectoral interdependency due to aggregate nature of the model; and
vii. the model does not reflect the present economic structure.

Blitzer and Eckaus (1986) developed a neo-classical CGE model for Sri Lanka with special reference to energy-economy interactions. This model focuses the impact of energy costs and prices on key macroeconomic variables and the industrial structure in Sri Lanka. Thirteen sectors were in the model including three energy sectors. The Leontief form was specified for all intermediate demand and the Cobb-Douglas production functions were used to specify the relationship between output and primary factors. Two consumer groups were identified and their

behaviour was characterized by an extended linear expenditure system. The base year was 1983 and three simulations were carried out to cover the 1983-89 period.

The main limitations of this model are:

i. it is more specific on energy issues and not disaggregated to capture all the economic sectors and relations;

ii. there is no easy access to model updatement or modification;

iii. the theoretical specification and estimation method imposes limitations on its use for other policy issues.

The structuralist CGE model was developed in Sri Lanka to ascertain the experience of stabilization and adjustment programmes in LDCs and to find an alternative to the orthodox IMF-World Bank stabilization approach (Jayawaradana et.al., 1987). This model concerns structural rigidities and is socially more appropriate than the neo-classical models. This model is demand driven but captured structural rigidities of the supply side. The agriculture sector has fixed supply and the manufacturing and service sectors have demand determined output. This model uses mark up price and allows for the effects of cost push inflation and effects of inflationary money creation.

This model is an aggregated one which consists of four sectors: (a) food, agriculture and processing, and export agriculture; (b) manufacturing; (c) mining and construction; (d) services, trade and transport. There are four income classes and two types of consumption groups. This model indicates that profit earners are faster at protecting their income from monetary inflation than wage earners. This model has been used to address the issue of macro economic adjustment experience in Sri Lanka during the 1970s and 80s by performing counterfactual simulations. The main objective of this simulation was to derive different outcomes of the different economic policies of the government. These outcomes indicate the feasibility of alternative adjustment mechanisms to achieve macroeconomic objectives of the adjustment programme. The main limitations of this model are: (i) it is not suitable to analyse industry-wide policy issues, (ii) it results in the model being more predictable, (iii) substitutability is limited, and (iv) neglecting supply-side factors and solution techniques hinders the flexibility of addressing wide-range policy instants.

More flexible two CGE models have been developed to capture the current structure of the economy by Bandara (1989) and the Center for International Economics (1991). These two

models are different from previously discussed CGE models with respect to the following features. First, they are large models which adequately represent the present structure of the economy and can be shocked in numerous dimensions to produce results on a large number of economic variables of interest to a wide range of policy issues. Second, these models use flexible solution methods which allow access for general users and local policy makers.

The first model (Bandara) is a neo-classical comparative static model which concerns the implications of various internal and external shocks. This model focusses the real side of the economy and its structure is closely associated with micro economic theory. This model highlights the role of relative prices and substitution possibilities in determining commodity trade flows and their effects on the economic structure and distribution of factor incomes. This model assumes compatible correspondence between industries and commodities and between occupational types of labour and household types. Location is the basis for categorization of labour and households into three groups. There are 24 industries each producing unique commodities. The main data base for the model is a 1981 input-output table which enables it to include different types of commodity and factor flows in the model. Expenditure elasticities have been estimated. The main equations of this model are derived from the constrained optimization of neo-classical production and utility functions. Producers choose inputs to minimize costs of a given output subject to three level constant returns to scale industry production functions. Households are assumed to choose their purchases to maximize additive utility function subject to aggregate budget constraints.

This model has been used to experiment with the historical magnitudes of terms of trade shocks and capital inflows during the 1978-82 period. These policy simulations are comparatively static. The combined effects on the macroeconomic variables and on the industrial structure indicate that the contradictory effects of the terms of trade shock would have been much stronger than expansionary effects of foreign capital inflows. Accordingly, if the economy adjusted fully, there would have been a substantial reduction in domestic absorption, real income and wages. This adjustment would have given a stimulus to the major tradable sectors while non-tradable industries would have contracted.

CGEM developed by the Centre for International Studies is very similar with respect to structure and solution methods of Bandara's model. However, this model is a more disaggregated one

which consists of 35 industrial sectors and three primary sectors. The main data base for this model is derived through updating the 1986 input-output table for 1989. This model has been used to examine the effects of changes in various policies such as elimination of tariffs, increase of tea and textile prices in the world market and reduction of foreign aid. The results of this model show that the Sri Lankan economy has benefitted from the continuation of trade liberalization and external shocks to the Sri Lankan economy and has considerable effects on export industries. The main limitations of these two models are as follows. First both these models are neo-classical and attempts have not been made to incorporate structural rigidities of the economy. Second, distributional aspects which are very necessary to incorporate are completely neglected.

The latest CGE model has been developed by Somarathana (1998). This model mainly concerns trade liberalization and its environmental implications with respect to land degradation in the non-plantation agricultural sector. This model is a further up-datement of Bandara's CGE model. Therefore, most of the estimation and limitations are in the same line as Bandara's model. However, this model is more disaggregated and three policy simulations have been done on the basis of liberalization, tariffs and enviornmental implications. The interesting policy result derived from this model is that liberalization does not have any damage on the non-plantation agricultural sector with respect to land degradation.

7. Computable General Equilibrium Models in MIMAP Regions

The main aim of CGEM is to convert the Walrasian general equilibrium structure from an abstract representation of an economy into realistic models of actual economies. Two types of CGEM or Applied General Equilibrium Models (AGEM) have been constructed for a wide range of policy issues in many developing countries. These policy issues are mainly the choice of development strategy, income distribution, trade policy, structural adjustment to external shocks, tax policy, structural change and long-term growth etc. See for an extensive survey of CGEM in developing countries Bandara (1991).

The first type of CGEM mainly involves modelling large scale and detailed structure of the economy with a static framework. These types of models incorporate production technology and consumption behaviour within a single time period and do not address the dynamic implications of policy changes. The second type of CGEM employs smaller scale models with less sectoral details. These models usually incorporate intertemporal structures which permit the evaluation of a wide variety of macroeconomic policies and their effects on growth, distribution and other macro aggregates. In the Asian region, many models have been developed to ascertain the issues such as lagged effects of policies, counterfactual simulations, alternative policy proposals, and implications of dynamic issues with respect to money, trade and tariff liberalization measures, structural adjustments and phasing of reform packages.

The following models have been constructed for The Philippines, India, Nepal, Vietnam and Bangladesh under the MIMAP initiative to ascertain the trasmission mechanism of macro adjustment policies on different social and income strata of the respective economies. Especially, these CGEMs ascertain the impact of macro economic adjustment policies on micro levels. This section is concerned mainly with CGEM developed under the MIMAMP project only. If the reader wants to know more about the CGEM in developing countries, see Bandara (ibid, 1991). Bandara's paper highlighted 61 CCGEM models developed for various policy issues.

7.1 CGEM for The Philippine Economy

This model was constructed by Caesar B.Cororation (1997) based on the 1990 Social Accounting Matrix (SAM) of The Philippines to analyse the real structure of the economy. This model is static, one period and has thirty four sectors. Seven sectors have been identified as agricultural and other 27 sectors identified as non-agricultural. Out of 34 sectors, 31 sectors have been identifed as tradable and three sectors (public health, education and central government) have been identified as non tradable. This model includes ten household types which are grouped into deciles. Three types of institutions are included: government, private corporations and unincorporate enterprises. The constructed CGEM does not consider the financial sector behaviourally even though The Philippine SAM includes the financial sector. However, The Philippine CGEM incorporated a system of accounting identities for the financial sector but it may be used to analyse issues related to changes of financial and monetary policies. The Philippine CGEM is mainly concerned with real sector modelling which can be used to analyse

one-period effects of output and factor price distortions. However, this model can be further developed into a 'dynamic multi-period model' by incorporating financial and real sectors together.

In order to construct the CGEM, the available SAM for 1990 has been reduced to a manageble level. In the original SAM , thirty seven production sectors and 155 rows and columns are available to show different intersectoral transaction flows of the different commodities, production sectors, institutions and financial assets. They have been reduced to thirty four production sectors and 63 rows and columns to form behavioural equations and accounting identites on each cell. This CGEM has thirty four production sectors, thirteen institution sectors, ten household sectors (categorised into deciles) and four capital institutions. Each institution invests its funds in four different placements: inventory of goods, physical assets, money assets and other financial assets. This model assumes two types of goods: tradable and non-tradable goods. Non-tradable goods are defined as those goods which have no import and export values in the SAM. They are public education, public health and general government services. The remaining thirty one sectors are considered as tradable sectors because they have import and export values. Three types of factor inputs are used in the production process: labour, mixed factor and capital (net operating surplus in the value added row of the SAM) in terms of agricultural and non-agricultural. The main income sources of institutions are factor incomes and secondary incomes .

Model Specification

Behavioural equations have been formulated for the seven sectors: import sector, export sector, domestic production, demand for factor inputs, income of institutions, consumption of institutions, savings and other sources of funds.

Import Sector

This sector assumes that imports (IMP_i) and domestically produced goods ($DOMSS_i$) are imperfect substitutes. Then the domestic consumers have the following CES utility function over the two types of goods (X_i = composite goods) .

$$X_i = A^c_i * \{ \delta_i * IMPi^{-\rho i} + (1- \rho_i)* DOMSS_i^{-\rho I} \}^{(-1/\rho i)}$$

Minimising the total cost

$$P_i^* X_i = (PD_i^* DOMSS_i)/PM_i^* IMP_i$$

Subject to Xi first order condition

$IMP_i/DOMSS_i = \{(PD_i/PM_i)^*(\delta_i/(1-\delta_i))\}^{\rho i}$

Consumers choose a combination of imports and domestic goods (IMP/DOMSS) depending upon their relative prices (PD/PM). The domestic price of imports depends on world price of imports, exchange rate and import tariffs.

Export Sector

Export sector (EXPi) assumes constant elasticity demand function:

$EXP_i = E_o^*(\Pi_i/PE_i)^{\phi i}$, here E_o = constant, Π_i = world price of i and PE_i = domestic price of exports. In supply side, product differentiation assumption is imposed over goods produced for domestic consumption and exports. Therefore, CET function formulated for total output (XDi) is divided into domestically consumed (DOMDDi) and exported goods (EXPi).

$XDi = A_i^{t*} \{\gamma i^* EXPi^{-\phi i} + (1-\gamma i)^* DOMDDi^{-\phi i}\}^{(1/\phi i)}$

Maximising total revenue: $PX_i^* XD_i = PD_i^* DOMDD_i + PE_i^* EXP_i$

Subject to XDi first order condition: $EXP_i/DOMDD_i = \{(PD_i/PE_i)*(\gamma i/(1-\gamma i)\}^{\phi i}$

This equation shows that supply of exports increases relative to the supply of goods for domestic consumption when the price of the exports increases relative to the price of the domestically consumed goods. This leads to divergence of export price and the domestic price of the good. The price of exports depends on world price of exports, exchange rate and export tax.

Domestic Production

Domestic production of goods is described by a Cobb-Douglas production function with three types of factor inputs: Labour (LBi), mixed factor (MXi) and capital (KAPi).

$DOMSS_i = A_i^* LB_i^{\alpha i*} MX_i\beta_i^* KAP_i^{(1-\alpha i-\beta i)}$

Demand for Factor Inputs

Under perfect competition, profit maximization requires that each of the factor price should equal to the value of the marginal product.

Then for **labour** $WA^*LB_i = XD_i^*PVA_i$, where WA is the average wage rate and PVA is the net value added price is defined as follows.

$PVA_i = PX_i - \sum_j IO_{ij}{}^*PX_j - (ITAX_i + DEPXD_i + IMPXD_i)$, where IO_{ij} input-output technical coefficient matrix, $ITAX_i$ is indirect tax rate, DEPXDi is the ratio between depreciation and output and $IMPXD_i$ is the ratio between imports and total output. For **mixed factor**: $RENTMX^*MX_i = XD_i{}^*PVA_i$, RENTMX is the average mixed factor rent. For **capital**: $RENTKAP^*LB_i = XD_i{}^*PVA_i$, where RENTKAP is the average capital rent. If the supply of these factors are fixed then each of the factors clear through changes in each of the respective factor prices: if the demand for a given factor decreases, the factor price would have to adjust to clear the market due to the fixed supply condition. Two separate average market clearing wage rates (agricultural and non-agricultural) exist in the economy. All these wage aspects can be used to analyse the income distribution. However, market clearing wage assumption is not pragmatic because it does not take into account wage rigidity mechanism. Especially the unemployment situation may not be analysed by using this CGEM which is directly related with income distribution. Furthermore, by incorporating Phillips curve equation, the delayed response in wage adjustment can be linked to changes in macroeconomic policies which may be extended as a channel to link the real and financial sectors together. The migration from agricultural to non-agricultural activities can be incorporated for this model which is relevant to adjustment policies and income distribution.

Income of Institutions and the Government

The income of institutions (households, unincorporated institutions and private corporations) consist of factor incomes, secondary incomes, remittances of workers working aboard, foreign transfers and other fixed incomes. The income of the government includes tariff revenue, export tax revenue, export subsidy, indirect tax, income from its capital endowment, secondary incomes, foreign transfers and other fixed incomes.

Consumption of Institutions and the Government

Consumption of households, unincorporated institutions, private sector and the government are specified in two stages as domestic consumption and import consumption. Domestic consumption of households depends on consumption share derived from SAM, average propensity to consume domestic product, income, and direct tax and price. Import consumption of household depends on factors such as exchange rate, average propensity to imports, income and direct tax rate. Consumption of institutions (CCinst) is uniformly specified for all institutions as follows:

$$CC_{inst\text{-}i} = CLES_{inst} * APCDOM_{inst} * Yinst(1\text{-}DTAX_{inst})/PX_i$$

Where CLES is consumption share derived from SAM, APCDOM is average propensity to consume derived from SAM, Y is income of institutions and DTAX is the direct tax. Government domestic consumption depends on consumption share derived from SAM, average propensity to domestic consumption, income, direct tax and prices. Import consumption depends of factors such as exchange rate, average propensity to import goods, income and direct tax rate.

Savings and Other Sources of Funds

Savings of the institutions are derived as residuals between income and consumption. The major sources of investible funds in The Philippine CGEM are institutional savings, institutional domestic borrowing from capital market and capital transfers from the rest of the world to the capital institutions. These investible funds are placed in four types of assets: inventory of commodities, physical assets, money assets and other financial assets. In The Philippine's CGEM, the level of these four assets depend on fixed proportions. Therefore, institutions cannot move their investible funds across physical, money and financial assets based on their rate of returns. This rate of returns is related to the interest rate which may help to ascertain the impact of monetary policy changes. These fixed proportions of physical assets can be used to determine the level of industry investment or capital expenditure of industries.

Domestic borrowing and lending are the two major sectors in the capital market which are not modelled behaviourally by the present Philippines CGEM but expressed in accounting identities. Foreign borrowing is treated as an endogenous variable and therefore, changes in tariff rates change accounting balances which automatically change foreign capital borrowing and finally clear both domestic borrowing, lending activities and the balance of payments. In the absence of a behaviourally specified financial sector in the CGEM, it assumes that foreign capital is readily available to finance all these gaps. The equilibrium condition in the model is the all industry demand (private and government consumption demand, intermediate demand, fixed capital formation, and changes in inventories and exports) equalling all industry supply (sum of the domestic production and imports).

Interpretation of the Parameters of the CGEM

The estimated main parameters of the CGEM are export demand elasticity, depreciation rate, weights used for aggregate price, government consumption expenditure, armington function exponent, CET function exponent, labour share parameter in the production function and mixed factor share parameter in the production function. In twenty two sectors export demand elasticity is more than one which means that a small change in price caused more changes in demand. Looking at this demand elasticity, devaluation can be recommended in order to increase export demand of these 22 sectors. In six sectors export demand elasticity is less than one which means that price changes are less responsive to export demand. Another six sectors have a unitary demand elasticity, which means that if prices change 10% the demand change is the same precentage (10%). Depreciation value is high in sectors such as textile manufacturing, electricity, gas and water. Government consumption share exist only in non-tradable sectors: public education, public health and general government services. Armington function exponent and CET function exponents have the same values for each production sector. But they are different for each production sector. They have high values for ten tradable sectors. Labour share is high in three non-tradable sectors. Moderate labour values have been reported in sectors such as construction, electricity, transport, electrical equipment manufacturning, private education and textile manufacturing. Mixed factor shares do not have values for three non-tradable sectors and five tradable sectors.

7.2 CGEM for India

CGEM developed by Pradhan.K and Sahoo.A, (1998) mainly concerns the importance of education and health in formation of human capital. This model comprises ten sectors: food grains, other agriculture, mining and quarrying, manufacturing industries other than capital goods, capital goods, construction, electricity, gas and water, education, health and other services. All these production sectors are producing a single and distinct commodity. Total output represents Leontief production function which says that total output equals intermediate goods and value added of that sector. The value added is a CES function of the primary factors. Labour and capital are the two factors of production. Households are broadly categorized into rural and urban sectors. Rural sector is further divided into five other sectors such as agricultural self-employed, agricultural labour, non-agricultural labour, non-agricultural self-employed, salaried class and other households.

The **production sector** of this model has been estimated in two scenarios: Scenario I (labour supply and stock of capital are fixed). Scenario II (capital stock is fixed and labour supply are function of health and education expenditure). Labour and capital can move across sectors and total labour and capital supply are simple aggregation of factors owned by the households. They are allotted according to the demands generated by different sectors. Each sector is a firm which maximises profits using factors and intermediate products. These firms work on zero profit condition: producers get revenue by selling their products and their payments to government as excise taxes, labour as wages, capital as rents and producer's as purchase of raw materials. Supply function for the commodities, demand function for the intermediate consumption and revenue for the government are derived according to the producers behaviour. Wage rate and rents are given which together determine the factor income.

Final demand of the model is estimated as follows: There are seven private consumers and the government in the model. Consumers' income source is the factor income but that includes the transfers they received and the taxes they paid. Government income mainly consists of excise tax on production, sales tax on goods, import duties and income tax. Government budget includes transfer payments to households. The households save a fixed fraction of their disposable income and spend the rest on consumer goods. Their demand for final goods depends on maximization of Cobb-Douglas production function subject to budget constraints. The government spends a fixed amount of income on health, education and other sectors. The total demand for commodities are the sum of the intermediate demand originating from producers and final demand from households and government. The only source of saving are households and they use these savings to buy investment goods.

Total supply is determined by the imports and exports demand. Standard small country assumption is applicable for the external sector. Six tradable goods are included in the model. Imports and exports are functions of world prices relative to the domestic prices and exchange rate. The quality differ among the domestic goods and importables which is explained through the Armington function. Domestic goods are not differentiated from exports. The balance of payments constraints holds for this economy. The sectoral sum of exports valued at the world prices is equal to the sectoral sum of imports into world prices.

The **government behaviour** is framed through a simplistic assumption: Taxes are the only source of government income and there is a balanced budget. A fixed amount of the revenue is spent on education, health and the rest are transferred to the households or spent on other commodities in fixed shares. The government neither owns factors of production nor is engaged in the production process.

Equilibrium conditions of the model are as follows: All the economic agents, the households, the producers and the government balance their budgets. GDP is same in income or product approaches. Domestic and import supply are functions of product and factor prices. The excess demand functions are homogeneous of zero degree in prices which equalized to zero. Weighted net price of imports act as numeraire. First scenario consists of 241 equations and endogenous variables, and the second scenario consists of 248 equations and endogenous variables.

The main data base is SAM which is based on input-output table for 1989/90. In addition to this, supplementary data sources such as national accounts, socio-economic and industrial surveys have been used. Under the two scenarios (labour supply fixed and endogenous), twelve simulations have been done. All these simulations showed that human capital formation contributes to the welfare and growth of the economy.

Another CGEM developed in India by Sarkar,.H. and Panada, M. (1992) is more or less in line with MIMAP objectives. The main aim of this model is to analyse import liberalization and its implications on structural changes in the Indian economy. This model consists of eight production sectors and three income classes. The eight production sectors are: foodgrains, other crop agriculture, livestock, forestry and other allied activities, consumer goods industries, intermediate goods industries, capital good industries, infrastructure and services. The three income classes are: agricultural income earners, non-agricultural wage earners and non-agricultural profit income earners. This model is built around the consistency framework of SAM. 115 equations have been arranged in the following eight blocks. Price-wage, output, income, savings-consumption, investment, government, accounting identities, monetary and trade. Five simulations have been done to ascertain the implications of import liberalization on structural change. This model proves that SAM based CGEM captures the structural details of a developing economy in a meaningful manner. Furthermore, the causalities of the model are clear and hence results are interpretable in terms of the structural processes operating in the model.

7.3 CGEM for Nepal

The Nepal CGEM (Sapkota, R and Sharama,.K. 1998) is a neoclassical real sector based model which is based on the assumptions of cost minimization by producers, utility maximization by households, perfect mobility of factors and competitive market driving profits to zero. This model can be used to analyse different economic and social policy changes such as tariffs, income and anti-poverty measures. Furthermore, this model captures relative price effects, resource allocation and other economy-wide effects. This model incorporates four types of economic agents: households (poor and non-poor), firms, government and the rest of the world. Interactions are between formal and informal sectors, agricultural and manufacturing, importing and exporting and traditional and modern and so on. The main strength of this model is its capability to trace economy wide implications of policy changes. Its main weakness is its traditional equilibrium nature which assumes competitive and static behaviour, unincorporation of the monetary sector and balanced government and external sector accounts. Equations are mainly formed to represent the following sectors: Production and factor demand, industry value-added functions, intermediate demands, labour markets, income, expenditure and savings of households and other institutions, foreign trade, price and equilibrium conditions.

The specification of model equations follows in line with the Dervis, de Melo and Robinson (1982) tradition. Production and factor demand equation is specified through the Leontief technology implying a fixed ratio between value added and intermediate demand. Industry value added function is derived through the Cobb-Douglas technology with the use of primary factors labour and capital. Intermediate demand is derived from Leontief technology. Intermediate consumption is derived from the sectoral production levels and input-output coefficients. Demand for noncompetitive imports is according to Leontief technology. Labour demand for the commercial sectors is derived from the optimizing behaviour of the Cobb-Douglas technology which is determined by the relative price of value added to the wage rate and value added generated in the sectors. Labour demand for government sector is determined by the ratio of value added to the wage rate. Household income consists of wages, rents, dividends and transfers. Household savings is defined as a fixed percent of the disposable income. Income of the firms consists of capital income, government transfers, income from the rest of the world. Savings of the firms is derived through deducting the capital taxes, dividends and transfers to the rest of the world from the firm's total income. Government income comprises taxes from households, capital and production taxes, transfers from the rest of the world, import duty and export tariffs.

Government savings is equal to government income less government transfers less total government consumption. The standard small-country assumption is used to foreign trade which assumes world price is fixed and perfect substitutability between domestic and internationally traded goods. Import demand function is derived from the cost minimization of the CES function and export demand function is derived from the CET function. The main data base of study is SAM which is based on the input output table for the year 1986/87.

Three simulations were done to ascertain the economy-wide effects of policy changes. Simulation I: reducing import duty and elimination of input tariffs. Simulation II: currency depreciation and Simulation III: increasing the skilled wages. The policy implications show that a) the reduction of tariffs in competitive imports and elimination of import duties on intermediate inputs increases the welfare of the poor households compared to the non-poor. b) devaluation hurts non-poor households and slightly benefits poor households. c) The increase in wages of the skilled labour and public servants increases the welfare of non-poor but hurts poor households very much.

7.4 CGEM for Vietnam

The Vietnam CGEM (Chan, N., H. Huu Dao, D. Minh Hai, et.al., 1998) was mainly developed to analyse the implications of tax reforms on both households and national level in Vietnam. This model concerns aggregate welfare impact as well as welfare of household groups ranked by income. The main focus of this model is on indirect tax reform even though it examines reforms in the external sector given both the revenue importance of the tariff and the role of tariffs in protecting domestic industry. This model is based on 1995 data, which use a small country assumption with Armington differentiation between imports and domestic products. On the supply side nested CES production functions are used. This model incorporates all the existing tax structures and five household groups, and six tradable and three non-tradable sectors. Each of the sectors in production uses primary factors (labour and capital) and intermediate inputs which is a composite of comparable domestically produced and imported goods with an Armington aggregate function. Other production functions used in the model are nested constant elasticity of substitution form and constant returns to scale. Final demand for each of the household groups are generated by maximizing a durable nested CES utility function subject to household budget constraints.

The results of this model indicate that there are gains to Vietnam from indirect tax reforms, but redistributive effects associated with these reforms are large and tend to swamp the aggregate effects. There is a sharp redistribution against those with lower income and who spend a significant fraction of their income on previously non-taxed products, and redistribution in favour of those spending a larger fraction of their income on earlier high taxed products; especially the richer households.

7.5 CGEM for Bangladesh

The main motive behind the building of CGEM for Bangladesh (Mujeri, K., 1998) is to develop systematic and analytical approach to take into account the inter-relationships of different macro policies and their impact on the economy. During the last decade, Bangladesh has implemented wide-ranging economic reforms in different sectors. Therefore, Bangladesh badly needs such a framework and capacities to ascertain the impact of these policies on the economy. At present, most projects implemented in Bangladesh are donor-driven projects and these donors use their own methods for evaluation of their projects and programmes. Partial analysis uses only sectoral data without an overall accounting framework. Therefore, it can only be used to ascertain first round direct effect and they cannot integrate many of the key behavioural issues and parameters of intended policy changes. Especially, the current system of evaluation pursued in Bangladesh may not be able to capture the distributional and allocative consequenses of policy reforms. The existing partial equilibrium and macro econometric modelling approaches in Bangladesh may not be able to ascertain intersectoral and interclass effects of policy changes. Bangladesh CGEM includes four sectors: production, consumption, government and foreign sectors.

Production sector comprises aggregated 26 sectors which is derived from 53 sector input-output table for 1992/93. Intermediate and final demand have been obtained from the Input-Output table. Sector specific value added is derived for the agricultural and non-agricultural sectors by using the capital and urban labour for the former and land and rural labour for the latter. This model differentiates five categories of sectoral capital, three types of financial assets and land.

The main assumption of consumption block is maximization of inter-temporal utility functions subject to inter-temporal budget constraints. Here, rural and urban consumers are the main consumer categories of the model. These consumers spend constant fractions of their income for

the goods which are derived by using the Cobb-Douglas production function. Consumers are different in initial resource endowments, financial assets and savings. The interesting feature of this model is that it permits rural and urban labour migration through wage differentials.

The government revenue is derived from direct and indirect taxes and expenditure accounts for public goods, subsides and domestic/foreign debt obligations. The government deficit is financed by monetary expansion and domestic/foreign borrowings.

Foreign sector comprises exports and imports equations. The aggregate demand for exports is determined by domestic and foreign price indices and world income. A combination of domestic and foreign inflation, exchange rate, elasticities and domestic supply responses determine aggregate exports. The demand for imports is taken as endogenous and is derived from the demand system. Foreign lending is exogenous indicating exogeneity of gross capital inflows. Changes in foreign reserves are endogenous. The exchange rate adjustments depend on the supply of foreign reserves.

Different sources of data have been used to estimate this model. Simulation has been carried-out in two phases. Simulation I is based on the depreciation of exchange rate at 10 per cent per year. Simulation II is based on 10 percent reduction of overall government expenditure. In general, the developed CGEM for Bangladesh is still at a preliminary stage and should be further developed to ascertain the impact of macro adjustment policies on major socio-economic characteristics of the rural society.

7.6 CGEM for Canada

The main objective of this industrial organization based CGEM model (Harris.R 1984) is to show that welfare gains from trade liberalization are substantial (four times higher) compared with the normal competitive model. Furthermore, this model differs significantly in the predictions as to the inter and intra industry pattern of adjustment to trade liberalization. It shows that due to trade liberalization firms achieve larger scale economies in response to larger world market and competitive pressure from the outside world. The final message of this model is that incorporation of industrial organization features to CGEM gives more consistent and reliable conclusions in the empirical evaluation of the trade policy at both industry and aggregate levels.

This model incorporates some of the features of micro economics industrial organization approach such as product differentiation, multi-product firms, economies of scale and so on. It has two factors (labour – fixed factor and capital services – mobile factor). Both these factors are mobile between industries and firms. Industries are divided into two categories: competitive industries with constant cost and non-competitive industries with increasing returns. This model estimated with and without product differentiation. Some assumptions of this model are unrealistic when it comes to small developing countries: price taker in import market and price maker in export market.

7.7 Other Qualitative Studies

i) Study on Bangladesh

A study on analysis of markets as conduits of macro-micro transmission in Bangladesh undertaken by the Centre for Integrated Rural Development for Asia and the Pacific.

This study was undertaken to identify factors that bring about poverty and those that perpetuate it. This study mainly examines the characteristics of important product and factor markets to identify the major conduits of macro-micro transmissions and interacting channels of macro impacts at the micro level. This study gave a special emphasis on the characteristics of the rural market and their links with the larger economy with focus on market participation and its dependence and access of the poor to various markets. The noteworthy features of this study are the special attention on the rural sector poverty, breakdown of product and factor market for different segments and an analysis of market participation, dependence and access of the poor to various markets. The main objectives of this study are:

1) Identification of major products and factor markets which may be included in the macro model.
2) Identification of major factors, institutional characteristics, and price setting behaviour in these factor and product markets.
3) Identification of the factors that determine access, terms and conditions as well as supply and demand, possible linkages across these product and factor markets.
4) Identification of closure rule for these product and factor markets.

The main aim of this study is to develop and operationalise a model rather than to generate data to run a model. The main purpose of this framework/model is to facilitate monitoring and analysis

of the impact of poverty stemming from key macro economic and structural adjustment policies. The main framework of this study is based on the World Bank developed "macro-meso-micro framework". This framework considers macro, trade, sectoral and social policies to constitute the set of socio-economic policies. Changes of these policies are presumed to affect the meso economic variables such as market prices, access to credits, roads, irrigation, and extension services etc. Impact of the latter changes at the household level and individual levels are the quarries under meso-micro linkages. Different product markets (rice, wheat, jute, spices and vegetables and so on) are analysed by using the Structure-Conduct-Performance framework.

8. Concluding Remarks and Policy Implications

The first part of this paper discussed the features of macro econometric models in LDCs and structural characteristics of the existing macro econometric models in Sri Lanka. This discussion showed that supply, demand, institutional and other structural characteristics of the LDCs should be embodied into the models to use them more pragmatically for policy purposes. Most of the macro econometric models were discussed with respect to their systems, expectations, dynamics and policy implications. This analysis showed their high aggregated nature which may be the main reason not to reflect the inter-sectoral flows. This high aggregated nature may be due to non-availability of data for each sector and activity. However, the available data is also under-utilised by some models. Most of the early macro models were just a presentation of structural equations for the Sri Lanka economy. But during the last years some structural models have attempted to derive policies which is a noticeable improvement. This improvement greatly helps to minimise the high academic nature of models and to make policy makers use these models for policy making in Sri Lanka. In recent years, some macro econometric models have attempted to incorporate supply constraints of the economy by constructing sub models for important sectors in the economy.

The second part of this paper dealt with various aspects of CGEM and Sri Lankan experience of these models. Firstly, it analysed some of multi-sectoral optimization, inter-temporal and linear programming models developed for Sri Lanka based on macro data frameworks. Thereafter, this paper analysed six CGE models developed in Sri Lanka with respect to their systems,

expectations, dynamics and policy simulations. A more elaborative evaluation has been made on CGEM to find special characteristics and features which can be used in future MIMAP modelling works in Sri Lanka. All the Sri Lankan CGE models have neglected the structural rigidities and distributional aspects of the economy. CGE models developed by Bandara (1989) and Centre for International Economics (1991) are good improvements with respect to their technical advancement and policy derivations.

The third part of this paper analysed CGEM developed for The Philippines, India, Nepal, Vietnam and Bangladesh under the MIMAP. Very detailed analyses of these models have been carried-out with respect to technicalities and policy-orientation in order to find their special features and characteristics to be used in Sri Lankan MIMAP modelling works. Most of these models have used Input-Output and SAM framework as their main data base. The Philippines CGEM mainly concerned real sector which can be used to analyse one-period effects of output and factor price distortions. However, this model can be further developed into a dynamic multi-period model by incorporating financial and real sectors together. The first Indian CGEM, developed by Pradhan and Sahoo (1998) mainly concerned the importance of education and health in the formation of human capital. The second CGEM for India developed by Sakar and Panda (1992) is mainly concerned with import liberalization and its implications on structural changes in the Indian economy. The main strength of the Nepal CGEM is its capability to trace economy-wide implications of policy changes. Vietnam CGEM was mainly developed to analyse the implications of tax reforms on both households and national level in Vietnam. The main motive behind the building of CGEM for Bangladesh is to develop a systematic and analytical approach to take into account the inter-relationships of different macro policies and their impact on the economy.

Generally, CGEM is rooted in a micro economic theory and is based on the optimizing behaviour of the agents. It emphasizes the consistency of the intersectoral linkages in production, consumption, trade and other economic activities with endogenous determination of prices. It allows for a distinction among the socio-economic groups in their income generation, consumption and other economic behaviour. Such a model has thus emerged as more suitable than any other class of models for investigating the economy-wide implications of macroeconomic policies in Sri Lanka. The imposition of the theory on the data in such models

gives the system a logical structure, provides ease of empirical interpretation, and gives clear policy implications.

Before developing CGEM for Sri Lanka, MIMAP model builders should be concerned with the following guidelines:

1. Carefully select the economic actors/agents whose behaviour is to be analysed. Input-Output and SAM framework may be helpful to decide the number of sectors in the economy.
2. Behavioural rules must be specified for these actors/agents in order to reflect their assumed motivations. For instance, producers maximize profits subject to cost and technological constraints and consumers maximize utility subject to income constraints.
3. Specify the right signals for the selected economic actors/agents. This may help to identify signals which direct agents/actors in the economy.
4. Specify the institutional structure of the economy. This may be between perfect competition and monopoly market situation.
5. Equilibrium conditions must be specified. These conditions must satisfy system constraints.
6. Good data base should be complied. This data base can be derived from the national accounts, input-output tables and socio-accounting matrix.
7. Calibration procedure should be specified.
8. Selection of appropriate procedure (linear or non-linear approximation methods) to solve the model for endogenous variables.

The building of CGEM to achieve the objectives of MIMAP for Sri Lanka may begin in line with neo-classical closed economy model which is mainly associated with SAM framework. This model includes real flows (production, consumption and investment demand, factor supply and demand), nominal flows (nominal income, consumption function and nominal savings), real system constraints for products and factor markets, nominal system constraints (savings-investment and price index), accounting identities (factor payments and total sales, consumption/investment demand and expenditure) and equilibrating price variables. This neo-classical model can be further extended to elasticity structuralist, micro structuralist or macro structuralist models based on the Sri Lankan MIMAP objectives. In later stages, the developed model can be extended to capture micro-macro interactions, dynamics, uncertainty and optimization aspects as well. However, instead of developing large scale general purpose macro economic models, MIMAP project can promote the development of small scale CGEM to capture a few important linkages in different stages.

The following features and characteristics should be incorporated in the Sri Lankan MIMAP CGE model to ascertain the effectiveness and the transmission mechanism of the macro adjustment policies. These features and characteristics have been derived through the analysis of Sri Lankan and other selected Asian countries' CGEM.

1) Policy instruments and targets should be treated explicitly, and the model should be able to trace the causal mechanisms at work linking the instruments to the targets. Fiscal and external deficits need to be included in the set of targets.
2) A minimum level of disaggregation of the economy is necessary. The main producing sectors should include exportables, importables, protected importables and non-tradables.
3) It should be possible to track, to some extent, changes in both real and monetary policy instruments at the macro level.
4) Product and factor prices should be endogenous and therefore their supply and demand must be modelled. Alternative market structures need to be identified and they need to be linked with policies.
5) Economic and social infrastructures need to be incorporated in the model and they should be linked with policies and household responses to changes in these infrastructure variables and need to be clearly spelt-out.
6) Sufficiently disaggregated household sector needs to be included.
7) Good coordinated framework should be formulated to collect and to minimise inconsistencies and duplication of data collection on macro and micro variables which is enormously required for the CGEM exercise.

Especially, the impact of structural adjustment policies on the agricultural sector should be ascertained with respect to input prices, efficiency of input uses, farm productivity and the growth of agricultural production. If Sri Lanka can develop this type of macro framework, it can be used on a regular basis to ascertain the impact of various macro economic policies on the economy.

The most important factor for the future economic modelling in Sri Lanka is to set up a good data base. This data base may help to popularise a quantitative culture in Sri Lankan policy making. A complete set of base period input output table, socio-accounting matrix and income distribution data is necessary to begin CGEM to achieve the main objectives of Sri Lankan MIMAP. At present, Sri Lanka has a good quantitative data base on income distribution aspects. But the Input-Output Table and SAM framework is somewhat old and not descriptive as it should be. The latest available Input-Output Table is for the year 1995 (Base Year 1970) and SAM framework for 1970. Especially, the available Sri Lankan SAM framework is a very primitive and

experimental one. Therefore, it is necessary to up-date these two in a more descriptive manner to capture the real structure of the Sri Lankan economy.

SAM based CGEM is an ideal tool to analyse the properties and implications of structural adjustment programmes implemented in Sri Lanka. This SAM based CGEM can capture structural details of the economy. Estimation of price and substitution elasticities are required on a regular basis. So far the elasticities in existing models are intelligent guessing and work of imagination of model builders. Most of the available CGE models in Sri Lanka and the Asian region do not consider structural rigidities, therefore it is necessary to consider this aspect in future modelling excerise. Most of the models are based on the unrealistic perfect competition and constant returns to scale assumptions but for a realistic nature imperfect competition and increasing returns to scale conditions should be incorporated. Most of the CGM concerns only the real sector rather than the monetary sector. Therefore, future CGEM should be concerned with monetary variables as well.

The number of challenges facing MIMAP model builders in Sri Lanka are: The relevant macro econometric and CGEM need to be re-specified in line with the MIMAP objectives and the real characteristics of the Sri Lankan economy. Furthermore, new estimation techniques should be selected to improve the efficiency and reliability of model selection, estimation and results. The most important factor is to convince policy makers in Sri Lanka to use these MIMAP models regularly for policy-making purposes. Furthermore, Sri Lanka should create a pool of human resources which may be very helpful to undertake CGEM and other quantitative exercises very efficiently. Especially, an independent or University based Advanced Econometric Institute may be established in Sri Lanka to popularise this CGEM and other modelling excerises into policy making process in public, private and NGO sectors and to have up-dated macro and micro data base for the modelling.

Finally, we can conclude that most of the macro econometric and CGE models analysed throughout this paper have relevant features and characteristics which can be used to build CGEM for Sri Lanka under the MIMAP. But these CGEMs are not complete substitutes to achieve MIMAP objectives because Sri Lankan economic, social, cultural and political features are different from other Asian countries and different CGEM have to be developed to achieve different objectives. However, if the MIMAP modellers can initiate the building of relevant

CGEM in their next phases to ascertain the transmission mechanism of macro adjustment policies, it would be very useful to find different outcomes and magnitudes of different macro policy changes in Sri Lanka.

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