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# Social Accounting Matrices(SAMs) and CGE Modeling: Using Macroeconomic Computable General Equilibrium Models for Assessing Poverty Impact of Structural Adjustment Policies

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## Abstract

The paper surveys selectively and analytically the implications of the various (macroeconomic) computable general equilibrium (CGE) models constructed for the purpose of integrating poverty analysis with the usual macroeconomic variables and relationships. It is found that a dual-dual production structure with sufficient details on the labor markets and household side can capture some of the effects of trade liberalization on poverty reduction. Further work needs to be done in expanding the export sectors and adding financial structure in order to carry out a detailed analysis of the impact of both trade and financial liberalization on poverty reduction. To this end a preliminary model is presented which can be compactified to carry out this type of analysis. Four broad categories of Asian economies are suggested for further analysis. As a first step in this direction, a modified model based on data about the structure of Bangladesh economy can be used as a "generic" model for the least developed poor Asian economies.

## Executive Summary

The main purpose of this paper is to offer an analytical survey of a certain class of models called computable general equilibrium models in order to understand the poverty reduction impact of structural adjustment policies. Understanding the impacts of the macroeconomic structural adjustment programs (SAP) on income (and wealth) distribution and poverty is important because of the vulnerability of the poor as a group in developing economies. There is much evidence that economic and financial crises often hurt the poor who have few cushions to protect themselves when a downturn occurs. There is also growing evidence that particularly for poverty reduction objectives, there are dynamic trade-offs in the implementation of SAPs.

There are both econometric studies at the aggregate level and some economy-wide Social Accounting Matrix (SAM)-based CGE models that have attempted to depict the impact of policy on poverty. However, the former are usually "kitchen sink" variety regressions without clear theoretical elaboration. The SAM-based CGE models are detailed but are usually without clear expositions of the causal connections between policies and poverty reduction. This paper explores the strengths and weaknesses of the various models on offer and tries to identify the uses to which they can be put for understanding the poverty reduction implications of macroeconomic policies. We need to know at what level of aggregation we can pose meaningful questions regarding the impact of policy on poverty reduction. In particular the impact of policies on the poor households as well as the near-poor through both direct and indirect causal channels need to be examined within the context of the various macro-models that have tried to include poverty analysis.

There are at least two aspects of any poverty impact analysis for a particular policy. These are: i) the impact on economic growth; ii) the impact on income and asset distribution. The growth effect on poverty reduction is then given by some estimated growth-poverty elasticity. In the second case, a more (less) favorable income/asset distribution for the poor may reduce (increase) poverty. A distributional neutrality assumption in a model simply allows one to look at the growth aspect by itself. Here, too, different sectoral growth rates and different sectors themselves may affect poverty differently.

The paper is structured in such a way that the connection between the basic policy issues and the particular modelling approaches can be discussed in a transparent manner. It begins with a discussion of the general macroeconomic policy issues arising out of program lending and their relevance to the poverty reduction strategy in the "post-Washington consensus" policy environment. This raises---among other things--- the questions regarding the measurement of poverty and the nature of macroeconomic environment in the developing economies. Consequently, it becomes necessary to discuss these measurement issues in the context of particular environments in developing economies. Thus the measurement aspects of poverty are followed up by a discussion of some pertinent issues regarding the general structure of macro-models. In particular, the possible use of SAM-based fixed price multiplier models is discussed. After this

extensive analysis and summing up of the link between poverty reduction and policies the paper then takes up the issue of CGE modelling for developing economies. Section 6 explores specifically the questions related to income distribution and poverty in CGE models for developing economies. In the penultimate section (section 7), I discuss the structure of what has been termed the "dual-dual" model In the concluding section I raise the question of how applicable these are for low and middle income Asian economies with large pockets of poverty. I end with some tentative suggestions regarding poverty analysis in an "extended dual-dual" framework for a low-income Asian economy such as Bangladesh as a first stage in building models that are applicable to Asian economies.

Our survey of modelling of poverty in a CGE modelling framework identifies three generations of such models for the developing economies. The first and second generation models included distributional questions, but did not address poverty explicitly. The third generation models do address the question of poverty reduction impact of SAPs explicitly. The main strength for poverty analysis purposes is the CGE models' ability to capture the interdependence (the general equilibrium effects) in the economy. In the dual-dual formulation, the further incorporation of interdependence among the labor markets in the rural and urban sectors leads to a more realistic assessment of the poverty reduction impact of trade liberalization. However, with a few exceptions, the CGE models of the third generation still do not capture the structure of the financial markets and analyze the impact of financial liberalization on poverty reduction. There are no models in existence which try--- in the spirit of the dual-dual approach--- to reduce the dimensionality of the standard static CGE models and still retain the causal structure essential for analyzing the poverty reduction impact of financial liberalization. It will be highly desirable to attempt an exercise for financial liberalization analogous to that of Stifel and Thorbecke for trade liberalization for some representative Asian economies.

Broadly speaking, there are at least four categories of Asian economies that could be the subject of such research. First, we have low income countries of South Asia. Here, a model based on an economy such as Bangladesh could offer some insights. The second category would include middle income Asian Developing countries such as Indonesia. Here, both national and regional poverty analysis would be equally important. The third and fourth categories will include the transitional low and middle income economies. As emphasized before, the four categories are not exhaustive, but they do cover a large number of developing Asian economies including the most populous poor countries with a large number of poor people.

Parsimonious financial CGE models for each category of these Asian economies can be constructed in such a way that there will be a built-in capability for poverty analysis. This can thus be the goal of the next phase of CGE modelling of poverty analysis. In keeping with the classification developed in the body of this paper, such a model could be seen as part of a new "fourth generation" of CGE models for developing economies. It will share with the third generation dual-dual models the concern for both incorporating poverty analysis in a general equilibrium framework, and for doing this with as parsimonious a structure as possible.

A properly constructed financial SAM will serve as the data-base for this

extended financial dual-dual CGE model (FDCGE model). The introduction of financial markets along with different financial assets, e.g., currency, and interest-bearing deposits on loans, stocks and bonds etc. would specify within limits the alternative forms of assets available to the portfolios of savers. The range of assets and the depth of the financial markets are issues that must be explored in the concrete historical and institutional contexts of specific types of economies prior to specifying any particular FDCGE model. The main participants in the financial sector are typically the firms, households ( mainly urban and upper income rural), the central bank, the banking system, and other financial institutions. Incorporation of rural-based financial institutions such as the Grameen Bank in Bangladesh can also be carried out if data are available. Modelling these markets adequately but economically so that focus is still on poverty and the model does not become unnecessarily complex will need to be the major emphasis of this work. For example, the behavior of the central bank may be specified in terms of (i) financing of government debt, and (ii) managing changes in foreign reserves, changes in money supply, required reserve ratio of the banking sector, and foreign and domestic borrowing. The domestic banking sector should be treated as fulfilling the task of financial intermediation between the savers and the borrowers. The other financial sectors can serve as alternative sources of financing in addition to the banking sector. There are specific issues with respect to the behavior of firms such as working capital management and new investment that require close attention when finance becomes an integral part of the CGE model.

Although the first stage of the modelling process can only aim at comparative statics experiments, an eventual dynamic extension will clearly be desirable. Such a compact and transparent dynamic CGE model will capture the economy wide financial structure and its linkages with the real sectors. Most importantly, such a dynamic CGE model will integrate the real and financial sectors modelling precisely with those characteristics of poor households that provide the crucial causal linkages between policy change and poverty reduction. Although not a substitute for specific micro analyses of poverty incidence, the relatively disaggregated macroeconomic CGE modelling can go a long way towards making available some useful poverty impact analyses for policy makers.

## 1. Introduction

Understanding the impacts of the macroeconomic structural adjustment programs (SAP) on income (and wealth) distribution and poverty is important because of the vulnerability of the poor as a group in developing economies. There is much evidence that economic and financial crises often hurt the poor who have few cushions to protect themselves when a downturn occurs. There is also growing evidence that particularly for poverty reduction objectives, there are dynamic trade-offs in the implementation of SAPs (Agenor 2002; Khan 1997, 1996). For instance, it is well known now that budgetary retrenchments associated in many cases with the SAPs have fallen largely on various types of social expenditures leading to a short-run worsening of the poverty situation in the absence of countervailing programs. In the medium to long-run, however, the SAPs are expected to bring down inflation, lessen credit rationing through lower borrowing rates for all by ending financial repression, and increase economic activities leading to sustained growth. To the extent that the poor are also beneficiaries of these outcomes, poverty is expected to decline.

This paper has two related goals. The first and the main aim is to survey selectively and analytically the implications of the various (macroeconomic) computable general equilibrium (CGE) models constructed for the purpose of integrating poverty analysis with the usual macroeconomic variables and relationships. Taking stock of our existing knowledge in this area will help clarify the relationships between macroeconomic policies and poverty reduction objectives, if and when such relationships are postulated to exist. Such a survey will also lead to a second, operationally relevant research question. Are there intermediate models---generic models, so to speak--- that can be used or constructed for the purpose of identifying the poverty impacts of policies both qualitatively and quantitatively? The second goal of the paper is to *explore* this question. It should be said at the outset that the answer to this question does not appear to be either an obvious “yes” or an obvious “no”. If such models can be identified or constructed their operational relevance for Asian Development Bank lending operations can be significant.

The emphasis on poverty reduction at the national and international levels as embodied for example, in the Millennium Development Goals, calls for a careful methodological approach to the estimation of the poverty reduction impacts of macroeconomic and other policy variables. A recent report produced at the Asian Development Bank sorts out many of the complex issues involved at the macro-, meso- and micro-economic levels and pinpoints the need for further conceptual and modelling work at the appropriate levels of (dis)aggregation(Bolt et.al.2003).The identification of the three different levels and treating the meso-economic level as the (institutional) link between the other two levels are encouraging in terms of understanding the complex causal relations that are involved in understanding and reducing poverty.

There are both econometric studies at the aggregate level and some economy-wide Social Accounting Matrix (SAM)-based CGE models that have attempted

to depict the impact of policy on poverty. However, the former are usually “kitchen sink” variety regressions without clear theoretical elaboration. The SAM-based CGE models are detailed but are usually without clear expositions of the causal connections between policies and poverty reduction (Azis, 2002). This paper will explore the strengths and weaknesses of the various models on offer and try to identify the uses to which they can be put for understanding the poverty reduction implications of macroeconomic policies. At this stage, we need to know at what level of aggregation we can pose meaningful questions regarding the impact of policy on poverty reduction. In particular the impact of policies on the poor households as well as the near-poor through both direct and indirect causal channels will be examined within the context of the various macro-models that have tried to include poverty analysis.

There are at least two aspects of any poverty impact analysis for a particular policy. These are: i) the impact on economic growth; ii) the impact on income and asset distribution. The growth effect on poverty reduction is then given by some estimated growth-poverty elasticity. In the second case, a more (less) favorable income/asset distribution for the poor may reduce (increase) poverty. A distributional neutrality assumption in a model simply allows one to look at the growth aspect by itself. Here, too, different sectoral growth rates and different sectors themselves may affect poverty differently. (Quibria 2002; Khan 1999; Thorbecke and Jung 1996).

A related issue is the heterogeneity of the poor households/individuals. The distinction between chronic and transient poverty (Jalan and Ravallion 1998 a and b; Hulme and Shepherd 2003) is important here for assessing the poverty impact of policies. Poverty severity differences among households (Thorbecke and Jung 1996; Khan1999, 1997) are also important to keep in mind in assessing the impact of policies on different types of poor households.

Partly following from the above considerations, the selection of a particular poverty index or poverty line can bias policy analysis as well. Some analytical effort needs to be devoted towards the clarification of these and related issues in the context of a particular class of macromodels. For example the headcount ratio, the Sen index and the FGT (Foster-Greer-Thorbecke) measures may lead in different directions as to which are the most appropriate groups/ geographical regions etc. for policy interventions. The across the board growth-poverty elasticity approaches via the headcount ratios given by one dollar/ two dollars a day poverty lines may be too crude for meaningful impact analysis. Clearly, these can be good starting points in the absence of further information, but good policy impact analysis needs to go much further.

However, the operational needs of the multilateral banks and data constraints on the ground may not leave much room or time for detailed classification of poverty, comparison of various indexes and further analysis of static vs. dynamic poverty and related issues. Nevertheless, it will be useful if our survey of models can lead towards the identification of simpler models or approaches that can stand at an intermediate level between large SAM-based economy-wide CGE models, for instance, and the existing ADB practice in many instances of fairly vague statements regarding poverty reduction

impacts of policies (Bolt et. al. 2003).

The structure of the paper is as follows. In the following section I discuss the general macroeconomic policy issues arising out of program lending and their relevance to the poverty reduction strategy in the "post-Washington consensus" policy environment. This raises---among other things--- the questions regarding the measurement of poverty and the nature of macroeconomic environment in the developing economies. Consequently, in the two sections following immediately), I discuss these issues in the context of developing economies. In section 3, I deal with some fundamental issues for the measurement of poverty. This is followed up in section 4 by a discussion of some issues regarding the general structure of macro-models. In particular, the possible uses of SAM-based fixed price multiplier models are discussed. Section 5 then takes up the issue of CGE modelling for developing economies. Section 6 explores specifically the questions related to income distribution and poverty in CGE models for developing economies. In the penultimate section (section 7), I discuss the structure of what has been termed the "dual-dual" model In the concluding section I raise the question of how applicable these are for low and middle income Asian economies with large pockets of poverty. I end with some tentative suggestions regarding poverty analysis in an "extended dual-dual" framework for a low-income Asian economy such as Bangladesh as a first stage in building models that are applicable to Asian economies.

At the outset it is fair to mention that even the poverty 'incidence analysis' at the micro level is not as straightforward as it seems. For example, even cash transfers may modify behavior. Such modifications can lead to general equilibrium effects in an economy wide set of repercussions. Typically, of course, most transfers are made indirectly--- through public spending and indirect taxation. The allocation rules are not always transparent and implementation is incomplete or distorted (Bourguignon et. al. 2002). More relevant to our purpose here, often macroeconomic and structural adjustment instruments and outcomes are also involved. The declared purpose of such reforms is to enhance economic activity and long-term rate of growth. In the short-run, however, the effects may even run in the opposite direction. A careful specification of the macro-models and the macro-micro linkage is thus a prerequisite for any meaningful and policy-relevant economic analysis.

Essentially there are three levels that such a relatively complete analysis of poverty reduction impacts of macro-policy changes would involve. First level includes the macroeconomic tools and models that will allow us to estimate and evaluate the impact of various exogenous shocks and policies on macro or aggregate variables such as the GDP/capita and its macro-components, the rate of interest, inflation/deflation via changes in the aggregate price level, the exchange rate and so on. The time frame must also be made explicit. At the second level we need to have tools and procedures for disaggregating the values of the variables obtained through our modelling and estimation exercises at the first level. Thus, at the end of our procedures at this level we will have at our disposal a disaggregated picture of the effects of policies on sectoral activities, and returns to factors and households at the appropriate levels of disaggregation. The last, bottom layer usually consists of a micro-module where an 'incidence analysis' can be

carried out through the manipulation of household micro data with the help of relevant theories of distribution, household income generation and consumption.

Anticipating the results of our review of the CGE models in particular, it will be seen that for developing economies these models can be conveniently categorized in three "generational" classes.[1] The first generation, starting with the pioneering works of Taylor and Lysy (1980) and Adelman and Robinson (1979) in the late 70s and the 80s focused increasingly on trade policy issues. The second generation in the late 80s and 90s made income distribution in the context of structural adjustment policies as the main focus, although it must be added that the pioneering works in both the Lysy and Taylor volume, and the Adelman-Robinson volume did not neglect distribution. The main difference is the explicit reckoning with Structural Adjustment Programs (SAPs). In the late 90s, explicit attention began to be paid to the poverty impact of SAPs within a CGE modelling context. In this context, with the Work of Decaluwe et. al. (1999), we seem to be in the third generation of CGE models where poverty impact has been modeled explicitly. At the end of the paper I will make some suggestions for perhaps a "fourth generation" of models for poverty in general equilibrium setting.[2]

[1] Like all historical classifications of ideas or schools of thought,this one also involves some arbitrariness. There is much overlap among the "generations" and at times, prescient anticipations of latter work. However, the categorization according to some prevalent general features during a particular period can still serve as a convenient marker or guidepost if we do not apply it in too rigid a manner.

[2] See also Clautier et. als.(2002) for a review of the CGE literature on the impact of trade liberalization on welfare and poverty. Cororaton(2003) is a detailed study of the Philippine tariff reform using the CGE-Microsimulation approach.

## 2. The General Policy Setting

The policy environment after the Washington consensus has increasingly moved towards both consolidating and augmenting the first generation reforms (Kuczynski and Williamson 2003). As is well known, in 1989, John Williamson had dubbed a list of ten reforms in Latin America "the Washington consensus"(Williamson 1990). The appellation gained wide currency and some may say, even notoriety. It covered the following ten points:

1. Budget deficits … small enough to be financed without recourse to the inflation tax.

2. Public expenditures redirected from politically sensitive areas that receive more resources than their economic returns can justify… toward neglected fields with high economic returns and the potential to improve income distribution, such as primary education, health and infrastructure.

3. tax reform … so as to broaden the tax base and cut marginal tax rates.

4. Financial liberalization, involving an ultimate objective of market determined interest rates.

5. A unified exchange rate at a level sufficiently competitive to induce a rapid growth in nontraditional exports.

6. Quantitative trade restrictions to be rapidly replaced by tariffs, which would be progressively reduced until a uniform low rate in the range of 10 to 20 per cent was achieved.

7. Abolition of barriers that impede the entry of new firms or restrict competition.

8. Privatization of state-owned enterprises.

9. Abolition of regulations that impede the entry of foreign direct investment.

10. The provision of secure property rights, especially to the informal sector.

As Williamson himself admits, "…from the start, the term "Washington Consensus" evoked controversy". Moreover the mixed results in the decade of the 1990s and the financial crises in Latin America, Asia and Russia led to some recent rethinking and a

proposal from some economists for an "Augmented Washington Consensus" (Rodrik 2002). The augmented list includes as "second generation" reform agenda a wide range of items from social safety nets and poverty reduction to anti-corruption policies and legal and institutional reforms. Some have pointed out that the expanded list sometimes expresses hopes and goals rather than specific policies. There is some truth to this. However, the expanded list does put the task of poverty reduction squarely on the agenda and raises important questions regarding whether and how the program loans and the conditionalities attached to them would lead to increased poverty reduction in the developing world.[3]

As an ADB internal document points out:

> In one sense program lending provides countries with external resources to ease the adjustment process in a situation in which absorption exceeds income; this is the 'living beyond ones means' scenario and program lending in this context is described as providing 'general balance of payments support' (where funds remain as reserves with the central bank) or 'support for the budget' (where the funds are sold to the private sector). Here the positive role of program lending is to allow a smoother and less destabilizing adjustment of expenditure to income and in particular to protect the real value of government expenditure that benefits the poor and vulnerable. This has been seen as a particularly important goal in economies in transition, where the government's revenue base has been eroded substantially.

The document goes on to point out a second dimension:

> The second dimension is the reform scenario in which program lending is designed to finance wide ranging policy reform at the level of individual sectors or the economy as a whole. Reform can embrace both adjustments to monetary variables – liberalizing prices as part of 'first generation reforms' - as well as institutional change under 'second generation reforms'.[4]

Program loans should in principle cover the costs of such reforms – both the costs of implementing change and of compensating those negatively affected. Insofar as good policy can be identified and implemented program loans can have wide-ranging positive effects through acceleration in economic growth.

The document recognizes that "….[i]n practice this simple distinction between the two dimensions of program loans may be blurred. Since countries thinking of implementing major policy reforms are often suffering from macro imbalances and since government funds are fungible, it is possible for countries to accept a program loan, but implement its reform conditionality only partially using the program funds also to support

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[3] There is, of course, the question of whether even the second generation of reforms will lead to the kind of sustained growth and poverty reduction that is anticipated. See for example, Hayami(2003) for questioning the view that growth and poverty reduction are sustainable. In particular, Hayami raises the issues of infrastructure building and other public investment projects that may still need to be undertaken by the public sector in order to make growth and poverty reduction sustainable.See also Naim(1994,2000,2002).

[4] See Rodrik(2002), and Naim(2002,200,1994)

government expenditure. The special evaluation study on program lending (ADB 2001, para 73) mentions that general balance of payments/fiscal support was 'frequently the primary interest to the DMC.' This may be one of a number of reasons why, as is discussed below, in terms of their impact most program loans have been found to be only partially successful".

This may have important implications for the poverty reduction strategy and programs. Effects of both the sectoral interventions and the macroeconomic policy reforms need careful monitoring and evaluation with an eye towards the overall poverty reduction strategy and specific targets. The document points out that there may not always be consistency between program loans and these targets. It mentions, for example,

> In principle under the present ADB system program loans should emerge from discussions on country strategies between the bank and DMCs. Hence the reforms to be facilitated by program lending should be consistent with and supportive of the country's poverty reduction strategy. In practice this consistency of approach may not always have been apparent. The bulk of program lending by ADB has been concentrated in agriculture, finance, industry, energy and more recently public sector management. Health, education and governance loans have been only a small proportion of the portfolio.

On the macroeconomic side, the indirect effects of policy reform on poverty reduction can mainly work through generating rapid growth. The growth-poverty elasticity is the crucial parameter here. We do have some evidence from a survey of the existing macro-models. In particular, the empirical relation between growth and poverty (Ravallion and Chen(1997), de Janvry and Sadoulet(1998), Agenor(2002)) estimated by using linear regressions where the change in the measured levels of poverty are explained by the growth of income or GDP/ capita and other variables can offer some useful policy guidance. The main lessons are that growth tends to reduce poverty, but the cross-sectional nature of this work makes it hard to apply it to any specific country.(see also Bourguignon(2002)). Hence the estimate in the cross-section that the poverty elasticity of growth is about 2, is not automatically operational for every case. Estimates for particular countries derived from plausible models using reliable econometric methodology are necessary.[5]

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[5] The document recognizes the link between growth and specific social expenditure categories and refers to some specific programs in three different countries. This type of analysis is clearly necessary, but may be too disaggregated for macromodels to address. However, much insight can be gained by such specific analyses alongside the standard multisectoral macro models. As the document points out:

Growth "…would allow greater expenditure to meet social development goals. Whether this expenditure is actually made by the public sector will vary depending upon government commitments to social targets, although a lack of public sector response can be compensated in part by private or NGO provision. Efficiency in public provision of social – essentially health and education services – has been addressed by recent program loans for these sectors, although their share of total program lending is small. A survey of program lending since mid-1999 reveals three main loans aimed explicitly at social development goals – the Health and Nutrition Sector Development Policy loan to Indonesia (March 1999), the Bangladesh Secondary Education Sector Development Program loan (June 1999) and the Bhutan Health Care Reform loan (September 2000). Of these the first aimed at maintaining social services

in the face of declining government revenue in the wake of the Financial Crisis. The other two loans aimed at general improvement in the efficiency of the education and health sectors, respectively. Governance issues are addressed directly by loans for public sector reform and privatization, as well as by programs designed specifically to address the legal and justice system. The more common program lending for governance purposes has had as the major objective improved public resource management and increased revenue collection capacity; for example the Madhya Pradesh Public Resource Management program (December 1999) and the Governance Reform program in Mongolia (December 1999). Overtly political governance issues have been addressed in just a very small number of cases, notably the Decentralization Support program in Pakistan (November 2002) and the Access to Justice program in Pakistan (December 2001)."See also ADB(2001;2002a,b,c;2003a,b)

## 3. Measurement of Poverty: Some Fundamental Issues

There is by now a vast literature on measurement of poverty. Theoretically, the seminal paper was Sen's 1976 axiomatization and the associated index that attempted to bring together the headcount ratio the income gap ratio and income inequalities among the poor within a consistent axiomatic framework. Since then, Sen and others following him have moved in the direction of a multidimensional approach to poverty as inadequate capabilities. However, for the purposes of this paper, I will keep within the income poverty concept where a single scalar, money income, is the only relevant variable of interest in measuring poverty and computing the various indexes.

The general intuition behind poverty measurement is that 'poverty' exists when a group of people in a particular society can not attain a 'minimum' level of well-being. The 'minimum' is at least partly dependent upon the prevailing standards of society. However, there are dimensions of well-being such as nutritional requirements that might actually constitute an absolute biological minimum. The idea behind absolute as opposed to relative poverty is that by using generally agreed upon minimum standards of well-being, we can, in fact, define an income poverty line. Such income poverty line gives the cut-off point below which everyone is deemed to be poor. The key questions in applying this idea of poverty for applied policy issues are:

1. How do we assess well-being?
2. How do we decide on a certain poverty line so that when a poor person crosses that threshold s/he is no longer poor?

These are the questions which ask us to identify who the poor are. Therefore, this can be called, using Sen's terminology, the "identification" of poverty. As a second step, the total picture of poverty is arrived at by aggregating. Hence, Sen's coinage of the term "aggregation problem". Head count ratio is one obvious example in which one simply counts the number of people below the poverty line and then divides this number by the total number of individuals in a particular society.

In terms of identifying the poor through the setting of the poverty line, a number of issues can arise. The following four questions are one way of raising some these issues (Fields 2001):

1. Is the basis income or consumption, and how comprehensively will either one be measured?
2. What is the income-receiving unit: individual, family, per capita, or adult equivalent?
3. Will there be a single poverty line or will there be separate ones for urban and rural areas or different regions of the country?
4. Is the poverty line income determined scientifically, politically, subjectively, or as a matter of convenience?

In terms of both identification and aggregation of poverty, the procedure depends partly on axiomatizing the concept of poverty so that any particular measure has a number of desirable properties. The most common axioms are focus, anonymity, population homogeneity, monotonicity or strong monotonicity, and distributional sensitivity. Among the commonly used indexes, the head count ratio fails both the strong monotonicity and distributional sensitivity axioms.

Since Sen's (1976) axiomatic treatment of poverty comparisons several new indexes of poverty have emerged. Among them is the one developed by Foster, Greer and Thorbecke (FGT).

The FGT index which we will meet later again as the index used most frequently in the macroeconomic models incorporating poverty analysis has many desirable properties. In addition to satisfying the monotonicity and distributional sensitivity axioms, it also has the property of being additively sub-group decomposable. This means that the index is decomposable by subgroups (according to region, income class etc.) among the poor.

Thus this index can take into account the intensity of poverty for different groups of poor people. This is done by looking at the deprivation of calories. The poverty measure is given by:

$$p = 1/n \, \Sigma (G_j / z)^a$$

where $n$ = *total population*
$q$ = *the number of poor*
$z$ = *the poverty line*
$G_j$ = *food expenditure shortfall of the jth individual* ($j = 1,2,\ldots,q$)

In the simulation a value of a = 2 is used. At a lower value of ‘a’ some of the axioms are violated. At a higher value of ‘a’ the shortfalls of the poorer segments are weighted more heavily; therefore the intensity of deprivation by the poorer segments (in particular the poorest) will be magnified for value of ‘a’ greater than 2. For this value of `a’ both the monotonicity and transfer axioms of Sen are satisfied. We may recall that both these axioms have to do with the sensitivity of the index to the incomes of the poor as opposed to simply the number of poor. Thus, the monotonicity axiom states that, ceteris paribus, a decrease in the income of a poor person should increase the poverty index. The transfer axiom states that, ceteris paribus, a transfer of income from a lower income poor person to a higher income poor person increases the poverty index. It can be checked easily that this is true for the FGT index when a = 2.

## 4. Macroeconomic Models for Developing Economies: SAMs and CGE

### A. Macroeconomic Models for Developing Economies: Some General Considerations

It is well known that the developing economies have special features that need to be recognized. Below, I first discuss some of these aspects of developing economies from the macroeconomic modelling perspective. Later in this section, a brief discussion of some "micro" institutional features that are also relevant for poverty reduction strategies are mentioned in order to round out the discussion. From the macroeconomic side, the following points are important[6]:

1) First, there must be an accounting framework and behavioral equations capturing some key aspects of macroeconomic modelling for developing countries. The most straightforward way of giving economic content to a set of aggregate accounting relationships is by adding appropriate behavioral equations and equilibrium conditions.

2) The accounting relationships that are relevant for a particular case depend on the structure of the economy. There could, for example, be a) "benchmark" accounting framework; b) particular features, modelling aspects such as alternative choices of disaggregation of production and consumption, structural features of labor market, degree of development of the financial system etc. c) behavioral functions, liquidity constraints on aggregate consumption; credit and foreign exchange rationing, debt overhang and its effects on production and private investment uncertainty and irreversibility effects on investment decisions; effects of financial repression, currency substitution, and informal financial markets on money demand etc.

3) Fiscal, monetary and exchange rate policies in developing countries are important features in most models. Data must cover a wide range of variables including industrial output, prices, wages, various monetary aggregates, domestic private sector credit, fiscal variables, exchange rates and trade variables.

4) Nature and implications of fiscal rigidities and the effect of fiscal deficits on a variety of macroeconomic variables are also important.

5) Developing country fiscal problems require special attention. Some of the

[6] See also, Agenor and Montiel (1999), Thorbecke and Morrison(1989), Khan(1983,1996,1997), Khan and Sogabe(1994), Khan and Sonko(1994) Khan and Thorbecke(1988),and Fields(2001).

most important features here are: high tax rates levied on a narrow tax base and heavy reliance on revenues from financial repression and multiple currency practices, on the inflation tax, and on excessive debt financing.

6) Exchange rates modelling require special attention as well. In particular, one needs to identify special features such as "fixed" with rationing and simultaneous transactions in parallel markets when these are present. Credibility and inflation under a fixed exchange rate regime also need particular attention. The association of quasi-fixed exchange rates with currency and financial crises makes this issue specially significant. Contractionary effects of devaluation may also destabilize the economy, and could be included as a theoretical possibility that may sometimes become a practical problem.

7) The role of labor markets in the context of short-run macroeconomic adjustment in developing countries is particularly important for analyzing the poverty reduction implications of macroeconomic policies. More specifically, labor market segmentation and sectoral wage rigidity need special attention.

8) It should also be recognized that by now there are both orthodox and "heterodox" programs and models of structural adjustment in developing economies. Alternative models of inflationary process are also available. However, the approach I have adopted here is intended to skirt unnecessary terminological (and at times, ideological) controversy. This 'ecumenical approach'--- to use Sherman Robinson's felicitous term--- adopted here is more concerned with the real contents of the models and their real world policy relevance.

9) Macroeconomic dynamics associated with monetary and exchange rate policy rules in a context where international capital mobility is imperfect need to be emphasized.

10) Three important issues that models must focus on in the context of exchange-rate based disinflation programs in developing economies are: i) output, ii) interest rates, iii) real wages.

11) It should be pointed out that with humility that none of the modelling approaches that are widely used in developing countries is at present able to adequately address the complex dynamic interactions between stabilization, growth and distribution. This makes the intermediate and longer-term analysis of issues related to external debt, capital inflows, and currency crises particularly difficult.

    Trade and financial liberalization and macroeconomic performance likewise become issues where the dynamic aspects are often treated simplistically. Problems of short-run macroeconomic management during the liberalization

process are also well known and need little commentary.

12) Political factors in the adoption and abandonment of stabilization and structural adjustment programs in developing countries effects are also of obvious importance, but are very difficult to incorporate in the standard macroeconomic models of applied general equilibrium variety. For example, it would obviously be important to include the effects of the presidential and parliamentary electoral cycle on the pattern of public spending in many Asian and Latin American countries. One could also make the same case for including an analytical framework for examining the linkage between exchange rate policy and electoral cycles.

Some questions that are relevant rise in light of the features discussed above are:

a. What structural changes need to be preceded by macroeconomic stabilization? Or, alternatively, can the two proceed concurrently?

b. What is the proper sequencing of the liberalization and reform measures ?

c. What “structural” differences between developed and developing economies, and “structural” similarities among the latter. Are relevant to model?

In response to the third question above, the following shared structural characteristics may be important:

1) Many agents possess significant market power

2) Macroeconomic causality in developing countries tends to run from “injections” such as investment, exports, and government spending to “leakages”, such is imports and saving;

3) Money is often endogenous

4) The structure of the financial systems can influence macroeconomic outcomes in important ways

5) The role of imported intermediate and capital goods as well as direct complementarity between public and private investment are empirically important.

Partly as a consequence of these features some have questioned the wisdom and efficiency of orthodox short-run macroeconomic policy prescriptions, particularly “shock treatment” in the form of fiscal austerity coupled with devaluation and tight monetary policy.

Disagreements among modelers also exist with respect to the identification of the source of inflation. The key controversy is about whether one should ascribe an

accommodative rather than a causal role to money supply growth. According to the nonmonetarist view frequently the source of inflation is slow relative productivity growth in agriculture (arising from poor land distribution and land tenure patterns) combined with administered prices (arising from noncompetitive market procedures and implying downward price rigidities) in industry, together with wage indexation. Monetary policy is perceived to be passive in the face of these already pervasive inflationary forces. Moreover, in part because of the roles of working capital and imported inputs, and in part because substitution possibilities are more limited than assumed by the proponents of orthodox macroeconomic management, a policy package combining devaluation with tight fiscal and monetary policies will result in stagflation in the short-run with little or no improvement in the external accounts. The alternative new structuralist policy prescription is not always clear, but it would in all likelihood contain a greater element of gradualism, direct intervention, and employ many of the means of medium term resolution of structural problems that are contained in traditional stabilization programs.

For the sake of parsimonious modelling, quite often a three good modelling approach is adopted. The three aggregated goods are non-traded domestic good, exportable good, and importable good.[7] Here, too, some important differences between the developed and developing countries need to be kept in mind. For example,

1) Developing economics, like small industrial countries, tend to be much more open to trade in goods and services than are the major industrial countries. In 1995 trade share of developing countries was 45% compared to G-7s trade share of 25 percent.

2) Developing countries typically have little control over the prices of goods they export and import. In particular, they often face exogenous terms of trade.

3) Over half of the exports typically consist of agricultural and primary commodities. Such an export structure needs to be modeled explicitly. The Mundell-Fleming model which has long been the work-horse of open economy industrial country model, assumes endogenous terms of trade determination, with the domestic economy completely specialized in the production of a good over which it exerts significant market power. The production structure most suitable for the analysis of developing country macroeconomic phenomena is instead likely to be the Salter-Swan dependent economic model or (as mentioned before) a three good model consisting of exportables, importables, and nontraded goods.

Such a production structure permits a distinction to be drawn between the exogenous terms of trade and an endogenous real exchange rate, which is the central intertemporal macroeconomic relative price in these economies.

[7] Later in the case of the "dual-dual" approach to modelling, we will find basically the same classification scheme. However, the number of production sectors in the particular model discussed in section 7 is four. The reasons will be explained in section 7.

In terms of the exogenous prices faced by the typical developing economy, both oil and non-oil commodities prices fluctuate a great deal.
The extent of external trade in assets have tended to be more limited in developing countries than in developed countries although this situation has recently begun to change in dramatic fashion for an important group of developing economies. The resulting instabilities however have also caused serious dislocations. In particular the increase in poverty in the affected Asian economies after the Asian Financial Crisis from July 1997 on should be kept.

In particular, the macroeconomic consequences of pegging, of altering the peg (typically devaluation) and of the rules for moving the peg are of particular importance in macro-modelling in developing countries. It is also useful to remind ourselves in trying to model the financial sectors that financial markets in many developing countries have long been characterized by the prevalence of rudimentary financial institutions. This is of particular relevance in analyzing the impact of policies on poverty reduction in low-income countries.

In light of the above, it should be apparent that in the modelling of these economies some macro-behavioral relationships may need to be modified. For example, we may need to incorporate the implications of credit and foreign exchange rationing in private decision rules where such rationing is present. This will affect, for instance, private consumption, investment, asset demand, export supply and import demand functions.

*Some Relevant Aspects of Public Sector Behavior*

The *Government Budget* is another important segment of a macro-model requiring careful handling. In particular, we need to remember that the composition of the government budget differs markedly between industrial and developing countries. Pervasive role of the state in many developing economies is reflected through the following factors, among others:

a. nonfinancial public sector – central government, local governments, specialized agencies, and nonfinancial public enterprises;

b. financial institutions owned by the government;

c. the central government absorbs a smaller fraction of output of developed countries than in developing countries;

d. the composition of spending differs between the two groups of countries. Developing countries spend proportionately more of their budget on general public service, defense, education and other economic services. Developed countries spend more on health and substantially more on social security.

e. Revenue: tax collection is hindered by limited administrative capacity and political constraints. This means that direct taxation plays a much more limited role than in developed countries. Direct taxes, taxes on domestic goods and services, and taxes on foreign trade account for roughly equal shares of total tax revenue in developing countries; in industrial countries income taxes account for the largest shares and taxes on foreign trade are negligible. In developing countries, the share of tax revenue raised from individuals is much higher than corporate income tax.

f. greater reliance on seigniorage (change in base money stock divided by nominal GDP). Seigniorage and inflation are positively related.

Three other dimensions of the budget institutions that have relevance for both growth and poverty reduction have been much discussed recently:

i. The nature and credibility effects of the constitutional rules that can be implemented to impose constraints on the size of the fiscal deficit, e.g., the balanced budget rule

ii. The procedural rules that guide the articulation and elaboration of the budget by the executive branch, its approval by the legislative branch, and its execution.

iii. The type of rules (whether collegial or hierarchical) that may enhance the transparency of the budgetary process e.g., Debt/ GDP upper limit constraint.

*Aggregate Supply and Labor Markets: some further issues*

Aggregate supply and the labor market are aspects that need some further attention before we close our discussion of institutional and macroeconomic aspects of macro-modelling. Here it is important to point out that through the cost of intermediate inputs that are imported; the exchange rate has an important influence on the position of the economy's short-run supply curve (SRSC).

SRSCs in developing countries may be significantly affected by working capital considerations. Many have claimed that costs of working capital tend to give interest rates and credit availability an important short-run supply-side role, although this is controversial and the empirical evidence is mixed.[8]

8 See Agenor, Pierre-Richard and Peter J. Montiel, Development Macroeconomics and the references there
for evidence on the empirical importance of the costs of financing working capital in Argentina and Korea respectively. If empirically relevant, the role of working capital in the short run supply curve would imply, for instance, that contractionary monetary policy may have short-term stagflationary consequences.

Although labor market institutions vary substantially across developing countries, the informal sector continues to play an important role in the determination of wages and employment in many of them. The modelling of short-run wage-setting behaviour represents one of the key differences between some of the major schools of modern macroeconomics, but most participants in the disputes acknowledge that country-specific institutional differences (such as the prevalence of staggered overlapping contracts in the U.S. or synchronized wage bargaining in Scandinavia) are important in determining the economy's SRSC. In this context, the role of economy-wide backward indexation mechanism in the context of disinflation programs has been studied extensively. Developing countries, as is well known, often have disguised unemployment. What is less well known is the prevalence of flexibility in many of the developing country labor markets as well. It would appear from the available evidence that many developing country labor markets have a high degree of real wage flexibility (Horton et al., 1994). Thus, for proper modelling of these markets in developing economies, a properly nuanced mix of flexibility and rigidity in specific labor markets is called for, rather than following one specific characterization for all labor markets.

As a result of the foregoing, the macroeconomic environment in developing countries is often much more volatile than that in industrial countries. The fundamental causes of the macroeconomic instability in developing countries are both external and internal. Small developing countries are price takers in the international markets for goods and services as well as financial assets. Therefore, these countries are directly affected by volatility in international markets. If we add to this the inflexibility and paucity of domestic macroeconomic instruments and we then face get a situation that is not easily amenable to control. There is also political instability in many countries resulting in frequent jumps in policy regimes. Such regime switch in a weak institutional environment creates the unfortunately typical developing countries scenario of a macroeconomic trajectory punctuated by a series of crises.

To sum up, economic boom and bust are much more prevalent in developing countries than developed countries. Such a history of macroeconomic volatility has serious economic costs-sometimes reaching into double-digit percentage points (See Khan, forthcoming 2004).

The above discussion is intended to give a fair summary of what is special about development macroeconomics. However, in order to link poverty analysis to the macromodels, more explicit recognition of the nature of market imperfections and of informal institutions that arise to fill the gaps is necessary. The literature in this area has experienced a tremendous explosion drawing on advanced work in game theory and the economics of information.[9] These new approaches try to explain empirical institutional features that include the following (Mookherjee and Ray, 2001).

[9] See for example, the papers collected in D. Mookherjee and D. Ray, Readings in the Theory of Economic Development, Oxford: Basil Blackwell, 2001, for a representative sample. See also, P. Bardhan and C. Udry. *Development Microeconomics*, Oxford: Oxford University Press, 1999, Hayami, *Development Economics* (1997) and Otsuka(2001,2000).

1) Fragmented credit markets;

2) Segmented labor markets;

3) Lack of market clearing manifested in unemployment and credit rationing;

4) Co-presence of different types of contracts, e.g., tenancy contracts of both fixed rent and share cropping varieties;

5) Pervasive long-term relationships between borrowers and lenders, employers, and employees, or farmers and traders;

6) Dual labor markets in which some workers enter into long-term contracts while others are employed to carry out similar task without such contracts at a lower level of wages;

7) Interlinked transactions and exclusive dealing between specific groups of agents across many markets for instance, credit and tenancy may be bundled together. Likewise, credit may also be bundled with employment or marketing contracts;

8) Asset ownership is the key to access to credit, tenancy or employment markets. Thus the poor have limited or no access to credit because they lack collateral assets. The poor also have limited or no access to employment owing to malnutrition, debilitating diseases or low levels of human capital.

9) Small farms show higher yields even when the large farms have better access to credit and technology.

10) Some markets such as the market for land sales are quite thin, leading to the persistence of tenancy and unequal land ownership in spite of the superior productivity of owner cultivated small farms.

11) Informal cooperatives and kinship networks are significant determinants of access to credit, insurance, technological information, water and common lands.

As Stiglitz (1994) and others have pointed out, the standard Arrow-Debreu model with a complete set of markets and optimizing agents cannot explain these phenomena. However, models using game theory and the approach of information economics largely pioneered by Stiglitz have amassed an impressive analytical record in explaining these features. While macromodels cannot be expected to accommodate all these features, in detail, at least the labor and credit markets need to be modeled carefully. This point is beginning to be recognized by development macroeconomists of virtually all persuasions

(Agenor and Montiel, 1999).

In surveying the macromodels attempting to link macropolicies to poverty reduction, we will need to ask how well some of these features are modelled in particular instances. Before turning to a discussion of some relevant economy wide CGE models, it is useful to discuss the economy wide data base for such models in the form of Social Accounting Matrices (SAMs). In the following sub- section, I present a brief discussion of the relevant issues and a particular case of SAM-based modelling as a background to the flexible price CGE models discussed from the following section on.

**B. Social Accounting Matrices as Consistent Economy wide Data Bases and Fixed Price Multipliers**

In this section the Social Accounting Matrix is presented as a data gathering framework as well as an analytical tool for studying the effects of various macroeconomic policies as well as the impact of sectoral growth on poverty alleviation. The origins of social accounting can be traced as far back as Gregory King's efforts in 1681, but more recent work stems from the attempts by Richard Stone, Graham Pyatt, Erik Thorkbecke and others. [10]

In the methodological framework of this particular study of CGE models, the SAM is viewed as a tool for mapping production and distribution at the economy wide level. In this sub-section, first a general SAM is described. Then it is shown how the method for studying the short-run effects of economic growth within this framework follows logically from its structure. The model used is a simple version of a class of SAM-based general equilibrium models. [11] It summarizes succinctly the interdependence between productive activities, factor shares, household income distribution, balance of payments, capital accounts, etc. for the economy as a whole at a point in time. Given the technical conditions of production the value added is distributed to the factors in a determinate fashion. The value added accrued by the factors is further received by households according to their ownership of assets and the prevailing wage structure. In the matrix form the SAM consists of rows and columns representing receipts and expenditures, respectively. As an accounting constraint receipts must equal expenditures.

As is elaborated further in Khan and Thorbecke (1988), the SAM framework can be used to depict a set of linear relationships in a fixed coefficient model. For deciding the question of determination, the accounts need to be divided into exogenous and endogenous ones. For instance, in the South African SAM used by Khan(1989) to analyze the impact of economic sanctions on the South African economy, there are three endogenous accounts. These are factors, households and production activities, leaving the government, capital and the rest of the world accounts as exogenous.[12]

In examining the poverty profiles in any country, one particular set of accounts assume special importance. These are the household accounts. The proper flow of income and expenditures need to be recorded for these accounts if an accurate picture of poverty as inadequate income/ consumption is to emerge out of a given SAM. For this reason, the classification of households needs special care. There are at least six aspects that need

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[10] For a description of SAM as a data gathering device, see G. Pyatt and E. Thorbecke, *Planning Techniques for a Better Future* (Geneva: ILO, 1976).

[11] In Walrasian general equilibrium models the flexible price vector determines the equilibrium. In a Keynesian (dis)equilibrium model in the short-run the quantities vary while the price vector remains fixed.

[12] See Khan and Thorbecke, op.cit., Ch. III. The presentations here follow the cited work closely.

careful attention.

These six aspects are:

(1) to classify households by socio-economic characteristics;
(2) to understand the income generation process by which the households receive their incomes;
(3) to pinpoint the distributional mechanisms;
(4) to understand the household consumption patterns;
(5) to link household income and consumption to social capabilities and functionings; and
(6) to estimate the resource generating capacity and resource absorbing capacity of the households.

If items 1-6 can be investigated systematically by combining economic and social modes of inquiry in a SAM, proper policy intervention for poverty reduction will become a more tractable exercise than it is at present. In particular, if disaggregated SAMs can be constructed at the local, sub-national levels, then intervention at the local levels may be much more effective than it has been historically in many cases. This is yet to be realized, but clearly is an important goal to pursue. I now turn to a discussion of another particular strength of the SAM framework for data gathering. SAMs have the consistency features that one needs in capturing economic flows for use in a general equilibrium framework.

The following tables illustrate in the aggregate the consistency requirements for building a SAM.

TABLE 1. SAM-FORMAT OF SNA-AGGREGATES, KENYA, 1982

(in KE million pounds)

| | FACTORS OF PRODUCTION | INSTITUTIONS | PRODUCTION ACTIVITIES | CAPITAL ACCOUNT | INDIRECT TAXES | REST OF THE WORLD (NET) | TOTAL |
|---|---|---|---|---|---|---|---|
| FACTORS OF PRODCUTION | | | G.D.P. at factor cost (2931.87) | | | Net Factor Income from Abroad (-133.80) | Domestic Factor Inocme (2798.07) |
| INSITUTIONS | G.D.P. at factor cost (2798.07) | | | | Net Indirect Taxes (467.59) | Net Non-Factor Income from Abroad (38.80) | Disposable National Income (3304.46) |
| PRODUCTION ACTIVITIES | | Total Final Consumption (2793.15) | | Gross Investments (764.71) | | Trade Balance (158.40) | Net Final Demand (3399.46) |
| CAPTIAL ACCOUNT | | Domestic Savings (511.31) | | | | Balance of Payments Deficits (253.40) | Total Savings (764.71) |
| INDIRECT TAXES | | | Net Indirect Taxes (467.59) | | | | Net Indirect Taxes (467.59) |
| TOTAL | Domestic Factor Income (2798.07) | Total Expenditure at Market pr. (3304.46) | G.D.P. at market prices (3399.46) | Total Gross Investments (764.71) | Net Indirect Taxes (467.59) | ---------- | |

TABLE 2. MODULAR COMPOSITION OF THE SAM

| | FACTORS OF PRODUCTION | INSTITUTIONS | PRODUCTION ACTIVITIES | CAPITAL ACCOUNT | INDIRECT TAXES | REST OF THE WORLD | TOTAL |
|---|---|---|---|---|---|---|---|
| FACTORS OF PRODCUTION | | | Income Generation Module | | | Factor Income Received from Abroad | Total Factor Income Received |
| INSITUTIONS | Income Distribution Module | Income Redistribution Module | | | Total Net Indirect Taxes | Transfers Received from Abroad | Total Disposable National Income |
| PRODUCTION ACTIVITIES | | Domestic Consumption Module | Industrial Transactions Module | Domestic Investment Module | | Exports | Total Demand |
| CAPTIAL ACCOUNT | | Domestic Savings Module | | | | Balance of Payments Deficits | Total Savings |
| INDIRECT TAXES | | Indirect Taxes on Final Consumption | Indirect Taxes on Intermediate Consumption | Indirect Taxes on Investment Goods | | | Total Net Indirect Taxes |
| REST OF THE WORLD | Factor Income Paid Abroad | Imports of Final Consumer Goods | Imports of Intermediate Consumer Goods | Imports Investment Goods | | | Total Payments Abroad |
| TOTAL | Total Factor Income Paid | Total Expenditure of the Institutions | Total Supply | Total Gross Investments | Total Net Indirect Taxes | Total Receipts from Abroad | |

In terms of the usefulness of the SAM information base, one can argue that not only is the National SAM a tool for the overall poverty reduction analysis, perhaps even more importantly, the building of local and regional SAMs will help the field-worker to understand the interrelations between households characteristics, the immediate causes of poverty and the best way to help specific types of households out of poverty. I now turn to the discussion of a particular type of modelling exercise that can be carried out with both the national and regional SAMs.

## Fixed Price Multipliers for National and Regional SAMs

In what follows, a national framework with distinct regions where the poor may be located is assumed. Suppose there are n regions indexed by i = 1, 2, .....,n. For each region i, there are intra-regional transactions as well as inter-regional transactions. Then, the national SAM can be disaggregated into 'n' Regional or RSAMs. The typical RSAM for region i can be schematically described as in table 3. Table 4 divides up the regional accounts according to whether these are endogenous or exogenous for the purpose of modelling.

TABLE 3. SIMPLIFIED SCHEMATIC SOCIAL ACCOUNTING MATRIX

| | | | | Expenditures | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Endogenous accounts | | | Exogenous | |
| | | | | Factors | Households | Technology production activities | Sum of other accounts | Totals |
| | | | | 1 | 2 | 3 | 4 | 5 |
| Receipts | Endogenous accounts | Factors | 1 | 0 | 0 | $T_{1.3}$ | $x_1$ | $y_1$ |
| | | Households | 2 | $T_{2.1}$ | $T_{2.2}$ | 0 | $x_2$ | $y_2$ |
| | | Production Activities | 3 | 0 | $T_{3.2}$ | $T_{3.3}$ | $x_3$ | $y_3$ |
| | Exog. | Sum. of other accounts | 4 | $1^1_1$ | $1^1_2$ | $1^1_3$ | t | $y_x$ |
| | | Totals | 5 | $y^1_1$ | $y^1_2$ | $y^1_3$ | $y^1_x$ | |

The above SAM framework can be used to depict a set of linear relationships in a fixed coefficient model. This is the essential point behind fixed price multiplier modelling approach based on a SAM. For deciding the question of determination of the equilibrium quantities, the accounts need to be divided into exogenous and endogenous ones as in table 4 below.

TABLE 4. SCHEMATIC REPRESENTATION OF ENDOGENOUS AND EXOGENOUS ACCOUNTS IN A SAM

| | | Expenditures | | | | Totals |
|---|---|---|---|---|---|---|
| | | Endogenous | Sum | Exogenous | Sum | |
| Receipts | Endogenous | $T_{nn}$ | n | Injections $T_{nx}$ | x | $y_n$ |
| | Exogenous | Leakages $T_{xn}$ | 1 | Residual Balances $T_{xx}$ | t | $y_x$ |
| Totals | | $y_n'$ | | $y_x'$ | | |

**Source:** H.A. Khan and E. Thorbecke, *Macroeconomic Effects and Diffusion of Alternative Technologies Within a Social Accounting Matrix* (Aldershott, U.K.,: Gower Publishing Co., 1988).

Essentially the regional income SAM above describes the circular process in which production activities generate household incomes (via the aggregation of factorial income per household category), and household expenditures which generate the demand for output. Other related variables such as government spending, imports and exports, transfers, etc. are linked to this core process where necessary. Transfers to the households from various other institutions including other household are also important for income determination and poverty analysis.

The 1978 income SAM for South Africa which is used by Khan (1999) for poverty analysis, for example, contains 28 separate productive activities. There is clearly enough detail here on the production side. The value added generated in these productive activities is distributed among landowners, capitalists, and forty occupation-by-race groupings. The realism of the classifications captures the nature of the past apartheid regime by indicating the determination of many occupational categories by racial factors. Finally, there are seven groups of households within each of the four racial groups. These are stratified by income. Therefore, both racial and economic stratification are embodied here. For the purpose of studying the relationship between growth and poverty the households are separated into rural and urban types in this paper. Further, within urban and rural areas, households are classified as high, middle and low according to economic status. This six-fold classification is more relevant for exploring questions related to poverty than the aggregated (i.e. urban and rural combined) approach of the original SAM. The justification for reducing the household types to three within the urban or rural categories is that the original household classification was somewhat arbitrary. The top three household categories could be aggregated as high income. The remaining six could be reclassified according to the information provided by the household expenditures survey data into low and middle categories.

The starting point for an analysis based on this SAM is the exogenous nature of the increased demand leading to sectoral output increase. The set of fixed price multipliers can then be used to ascertain the impact of this increase in output on the incomes of specific household groups.

Looking at tables 3 and 4, which represent a SAM, we can see immediately that

$$y = n + x \qquad (1)$$
$$y = 1 + t \qquad (2)$$

Now if we divide the entries in the matrix Tnn by the corresponding total income (i.e. Yn), we can define a corresponding matrix of average expenditure propensities. Let us call this matrix A. We now have:

$$y = n + x = Ay + x \qquad (2.1)$$
$$y = (1 - A)^{-1}x = Mx \qquad (2.2)$$

M can be called the matrix of *accounting* multipliers. for these multipliers,

when computed, can account for the results (e.g. income, consumption, etc.) obtained in the SAM without explaining the process that led to them. Let us now partition the matrix A in the following way.

$$A = \begin{pmatrix} 0 & 0 & A_{1.3} \\ A_{2.1} & A_{2.2} & 0 \\ 0 & A_{3.2} & A_{3.3} \end{pmatrix}$$

Given the accounts factors, household and the production activities, now we see that the income levels of these accounts (call them $y_1$, $y_2$, and $y_3$ respectively) are determined as functions of the exogenous demand of all other accounts. In this respect, what we have is a reduced-form model which can be consistent with a number of structural forms. This is quite satisfactory as far as tracing the effects of a certain injection in the economy is concerned or for prediction purposes when the structural coefficients are more or less unchanged.

One limitation of the accounting multiplier matrix M as derived in equation (2.2) is that it implies unitary expenditure elasticities (the prevailing average expenditure propensities in A are assumed to apply to any incremental injection). A more realistic alternative is to specify a matrix of marginal expenditure propensities ($C_n$ below) corresponding to the observed income and expenditure that prices remain fixed. Expressing the changes in income (dy) resulting from changes in injections (dx), one obtains,

$$\begin{aligned} dy_n &= C_n dy_n + dx \\ &= (I - C_n)^{-1} dx = M_c dx \end{aligned}$$

$M_c$ can be termed a fixed price multiplier matrix and its advantage is that it allows any nonnegative income and expenditure elasticities to be reflected in $M_c$. In particular, in exploring the macroeconomic effects of exogenous changes in the output of different product-cum-technologies on other macroeconomic variables, it would be very unrealistic to assume that consumers react to any given proportional change in their incomes by increasing expenditures on the different commodities by exactly that same proportion (i.e. assuming that the income elasticities of demand of the various socioeconomic household groups for the various commodities were all unitary). Since the expenditure (income) elasticity is equal to the ratio of the marginal expenditure propensity ($MEP_i$) to the average expenditure propensity ($APE_i$) for any given good i, it follows that the marginal expenditure propensity can be readily obtained once the expenditure elasticity and the average expenditure propensities are known, i.e.,

$$Ey_i = \frac{MEP_i}{AEP_i}$$ , *where Eyi is the income elasticity for*

$$MEP_i = E\,y_i . AEP_i$$

Thus, given the matrix $A_{32}$ of average expenditure propensities, and the corresponding expenditure elasticities of demand, $y_i$ the corresponding marginal expenditure propensities matrix $C_{32}$ could easily be derived.

For analyzing poverty both at the national and the subnational levels these multipliers can be further decomposed in terms of their effects on poor households incomes Tracing out these effects can be computationally demanding, but under assumptions of distributional neutrality of growth, the pure effects of growth on poverty have been estimated by Thorbecke and Jung(1996) for Indonesia and by Khan(1999) for South Africa. The latter used the South African SAM described above and found that the lack of human capital and more generally, basic capabilities in Sen's framework, was the main reason why growth left out the rural Black poor in particular.

## 5. CGE Models: First and Second Generations for Developing Economies

In order to discuss how to incorporate poverty analysis in a CGE model, we need a clear understanding of the structure of CGE models as such. As a first step in understanding the CGE models, we can start with the Walrasian "fundamentalist" approach to general equilibrium. Essentially, the problem here is to find a set of prices (a price vector) that will clear all markets.[13]

The producers maximize profit and the consumers maximize utility. All markets including futures markets must exist and all uncertainty must be subject to actuarial calculation of risk[14]. It is clear that while theoretically elegant and analytically impressive, the conditions in many actual economies do not approximate this theoretical model.

In the Keynesian type macroeconomic models at any rate, there can also be underemployment equilibrium. There is thus a tension between such macroeconomic models and the Walrasian general equilibrium models where full price flexibility ensures full employment at market clearing wage level.

As Robinson (2003) observes:

> The literature on CGE models is replete with debates about the macro properties of these models, and a number of different schools of thought have emerged concerning how, or indeed whether, one should incorporate macro features into these SAM-based models. No clear consensus has emerged, which is hardly surprising since the debate really concerns the theoretical dividing line between Walras and Keynes, and the micro foundations of macro models--- or the lack thereof. (p. 1)

It is not relevant here to outline the contours of this debate, except to keep in mind that one of the uses of the fixed price multipliers model discussed in the previous section is to capture the unemployment equilibria under the assumption of excess capacity. I will also review the most significant aspect of the differences among various models which arises often from the choice of different closure rules. However, we need to keep firmly in mind that a CGE model in its origin--- and initial historical development--- is Walrasian in spirit.

At the applied level, a CGE model incorporates all the flow variables that can

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[13] Actually, it is necessary and sufficient for all but one of the markets to be in equilibrium. As is well known, by "Walras' law" when all but one markets clear, the last one must clear also.

[14] Formally, the maximization of expected utility must be possible. For this, an axiomatic characterization was given by von Neumann and Morgenstern. A necessary condition is the possibility of expressing all states as quantifiable probability distributions.

be captured in a SAM. [15] These include production activities, factorial income distribution and household income distribution among other variables. The importance of both the factorial income distribution and household income distribution for poverty analysis in a CGE model are intuitively obvious. However, proper modelling strategy for these distributions in a CGE model is far from obvious. Later, we will have an occasion to deal with the issues that arise in this context in some concrete examples of CGE models for poverty analysis.

As implied before, the Walrasian spirit of a CGE model is shown in its determination of only relative prices, with some price index being chosen as the numeraire. The model also incorporates the assumption of 'no money illusion'--- all supply and demand equations are homogeneous of degree zero with respect to prices.[16] If all prices are multiplied by a fixed number, the equilibrium quantities do not change at all.

As a matter of historical record, it has been a standard practice of CGE modelling to specify fixed supplies of factors of production such as various types of labor and capital, or aggregate indexes of these, and carry through the implications of the assumption that all markets must clear. These "classical" CGE models calibrate wage and rental rates to employ all of the exogenously specified labor and capital. In many "applications", the guiding idea has been to introduce distortions to the 'equilibrium price vector' and calculate the resulting inefficiencies. In this sense, CGE models have been used as a normative check for distortions and their costs against the benchmark of a Walrasian market clearing price system.[17]

There is also much discussion in the CGE modelling literature about the various "closure rules" for the models. The discussion about macro-closures, initiated by Sen (1963), was revived by Taylor and Lysy (1979) who found that the choice of macro-closure to a large extent affected the policy simulation results obtained with a CGE model. As the previous discussion already indicates, the macroeconomic modelling is forced to depart from the Walrasian assumptions embodied in a "fundamentalist" CGE model. This also leads to the "closure rule problem". Because the short-run macro CGE models do often deviate from the Walrasian closure, a separate literature has grown up around the various alternatives.

There are mainly two ways to interpret and define the closure rule problem. In mathematical terms, the problem boils down to the simple notion that the model should consist of an equal number of equations and endogenous variables. Thus, the closure rule problem is the decision the model builder has to make on which variables are

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[15] For a succinct discussion of some of the relevant features of the applied models for policy analysis, *see* Yao, Shujie and Aying Liu, "Policy Analysis in a General Equilibrium Framework" *Journal of Policy Modelling*, 22(5):589-610, 2000.

[16] In macroeconomic terms, we can include the assumption of neutrality of money. And thus create a 'classical' model.

[17] It should be noted, however, that the assumption of full employment means that the economy is at the wrong point of the (multidimensional) production possibilities frontier, not inside it.

endogenous and which variables are exogenous. Alternatively, if the model is built in the Walrasian tradition and all decisions are based on optimizing behavior, the closure rule problem involves the introduction of macroeconomic constraints that impinge upon the microeconomic behavior of individual agents. One then needs to introduce additional balancing equations. (Ginsburgh and Keyzer, 1997). In general, a closure rule is determined by the theoretical preferences of the model builder and, in her view, empirically the most plausible adjustment processes.

In the early works that used CGE models for development policy work, much time was spent in finding ways to model the various distortions in the foreign trade sectors. Thus, modelling exports, imports, balance of trade and balance of payments became important items on the modelling agenda during the 1980s. After trying various approaches, a general consensus was reached. The consensus approach admits imperfect substitutability between imported goods and their domestic counterparts. The Armington assumption is invoked by almost all modelers.[18] The Armington assumption regarding imperfect substitutability has been extended to the modelling of exports as well. The most common approach now is to specify sectoral constant elasticity of substitution(CES) import demand functions, export transformation functions that assume constant elasticity of transformation(CET) and aggregation functions based on these.[19]

We may recall that starting with Hume and his price-specie flow mechanism, the classically inspired trade theories have implied a trade balance of zero in equilibrium. But in the real world data the trade balance is rarely zero. Does this mean that the equilibrium assumption is somehow violated? The most widely practiced way of handling this nonzero trade balance is to make it exogenous. Typically, trade imbalances find their counterpart in the saving-investment imbalance.

Looked at in this way, trade imbalances can be treated as foreign saving flowing in with a trade deficit, and of savings flowing abroad when trade balance is positive. However, this does raise the question of why people at home or abroad would be willing to save and lend--- a question that can only be answered in an explicitly intertemporal model. Thus, static CGE models which treat trade balance as exogenous are, in fact, compressions at a point in time of a more fully specified intertemporal equilibrium model.

There is also the related issue of how to bring in balance the traded with the nontraded sector, and the domestic economy with the rest of the world. This is done by making flexible another relative price. This is the relative price of traded and nontraded goods, or under the purchasing power parity and small country assumption, the real exchange rate. Naturally, modelers tend to specify an implicit functional relationship between the real exchange rate and the trade balance. Increased flow of foreign savings raises the relative price of nontraded goods which is equivalent to an appreciation of the real exchange rate in these models (Devarajan, Lewis and Robinson, 1993). There is a

[18] See Armington(1969).

[19] The theoretically inclined reader will recognize this as being in line with the Salter-Swan model.

shift of production away from exports goods producing sectors to nontraded goods and services. Consumers shift demand to cheaper imports and the new trade balance equals the exogenous flow of higher foreign savings.[20]

This is perhaps a good place to shift our attention from foreign savings to domestic savings and investment, with the role of the government as a key macroeconomic entity. Recall from the previously introduced SAM accounts that the savings-investment account collects savings and spends money on investment goods. The flow equilibrium condition is that savings must equal investment. Some mechanism is clearly needed to achieve this balance, as our previous discussion of the closure rules already indicated.

The common strategy here is to specify savings parameters by household types. These fixed parameters map income to savings. A fairly common (neoclassical) assumption is also to assume that all savings are spent on investment. Thus under this closure rule there is no "paradox of thrift". Either through loanable funds markets or a more direct allocation rule( this is often the case), savings are translated into investment. However, this is not the only way to relate savings and investment, and even here, as the reference to the loanable funds markets hints, the full specification of a 'savings-driven' model on the financial side is often missing. Important questions regarding the saving-investment links need to be raised. These include: why save at all ? Why spend on investment rather than on consumption? Who owns the new capital stock? Do actors have and care about an asset portfolio? Introduction of proper dynamics is necessary to answer these and other similar questions.

The question of private savings is also related to that of public savings and dissavings, as the case may be. But the government does more than generating savings or dissavings. It collects taxes, makes transfer payments and purchases goods and services. Through all these activities it can affect the flow of income and consumption of all or some socioeconomic groups. Hence, an intuitive link between government's actions and poverty is justified. Later, we will see how this link can be made more explicit in a causal sense. For the moment, let us simply observe that in most CGE models government is a rules-based (but not necessarily a utility maximizing) actor. Typically, the monetary side is absent or sketchy. Usually, there is a flow-of-funds specification, but no consideration of how the government finances its deficit. There is simply a crowding out of private investment.

Thus, the trade balance, private saving-investment balance and the public sector balance are all treated in a somewhat *ad hoc* fashion, but in a way this treatment broadly respects the relative price flexibility in the Walrasian spirit. However, the previous discussion also raises the question of including dynamic considerations explicitly. In particular asset endowments, markets and expectational dynamics may need to be included. Opening up the model in this way, also carries the danger of making it less tractable. This explains why dynamic CGE models to this day are not as

[20] Therefore, this is properly described as a comparative statics exercise with the chain of causality starting with the exogenous change in foreign savings and ending with a new trade balance.

well developed as a reasonable theoretical critique would demand. It would seem reasonable, for example, to expect that an “ecumenical” approach could postulate the possibility of unemployment, informal labor markets, financial markets for various assets and their relation to the real sectors. Such a “realistic” model could better capture the location and dynamics of poverty among other things. Better policy analysis prospects may be an important motivation for searching for such models.

## 6. Income Distribution and Poverty in CGE Models: the Third Generation of Models for Developing Economies

Since the publication of the pathbreaking book by Irma Adelman and Sherman Robinson on Korea in 1979, the literature on applied general equilibrium modelling has exploded. It is not relevant to review all of them. In this section our focus is narrowly on the strand of literature dealing with income distribution and poverty. The seminal contribution by Adelman and Robinson already had used an implicit SAM to capture both factorial and household income distribution in a disaggregated manner. At about the same time the work of Lysy and Taylor(1980) focused on Brazil and made distributional aspects a part of the overall analysis. Dervis, De Melo and Robinson(1982) also addressed distributional issues in the general equilibrium modelling context. However, real concern with distribution and poverty analysis started towards the end of 1980s, after a decade of structural adjustment policies. Under the aegis of the OECD, Thorbecke (1991) for Indonesia, de Janvry, Sadoulet and Fargeix( 1991) for Ecuador, Morrison(1991) for Morocco and Chia, Wahba and Whalley for the Ivory Coast are some modelling examples from this "second generation" of CGE models for developing countries that addressed income distribution and welfare issues in greater detail than before.A number of papers by Bourguignon and others also contributed to this stream.[21]

We can summarize the main analytical developments in modelling distribution upto this point by noting that these first and second generation models relied on a representative household assumption and fixed distributional coefficients for the household income distribution. Therefore, the analysis of poor households was necessarily coarse. No information about intra representative household income distribution and poverty was sought or used. The multiplier decomposition models of Thorbecke and Jung(1996) for poverty analysis in Indonesia and Khan(1999) for South Africa also share this weakness.

However, by utilizing the information in household income and expenditure surveys, it is now possible to generate intrahousehold groups income distribution and poverty profiles. It is also possible to use these profiles as part of the initial calibrating exercise in CGE models. A set of recent modelling efforts have been directed in

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[21] See in particular, Bourguignon, F., J. de Melo, and A. Suwa, 1989. Distributional Effects of Adjustment Policies: Simulations for Two Archetype Economies, Background Paper for 1990 WDR, World Bank.

Bourguignon, F., J. de Melo, and A. Suwa, 1991. Modelling the Effects of Adjustment Programmes on Income Distribution, World Development.19:11 1527-1544.

Bourguignon, F., W. Branson, and J. de Melo, 1989. Adjustment and Income Distribution: A Counterfactual Analysis. World Bank, PPR Working Paper 215.

For a concise review of recent issues in both macro and micro aspects of poverty analysis, see Bourguignon, F., L. Pereira da Silva and N. Stern (2002), *Evaluating the Poverty Impact of Economic Policies: Some Analytical Challenges*, draft paper, World Bank.

precisely this direction.[22] Here, the paper by Decaluwé, Bernard, A. Patry, Luc Savard, and Erik Thorbecke (1999) is a pioneering piece. Another paper by Decaluwé, Dumont and Savard (1999) tests the relevance of intrahousehold distributional information for poverty analysis. Based on an archetypal economy with four areas of activity (agriculture, industry, marketable and nonmarketable services), three factors of production (capital, skilled and unskilled labor) and four types of agents(rest of the world, government, firms and households), their approach is to isolate the contribution of average income variations, poverty line changes, and income distributional changes and then to look at the effect of these variations on various poverty indicators. Their results are unambiguous. They clearly highlight the relevance and significance of intrahousehold group information. Of the three influences they discuss, the changes in poverty line in a price-endogenous model accounts for most of the changes in poverty. Therefore, both intra-household group information and price endogeneity that allows us to compute a new nominal poverty line after each policy change are important. Azis (2002) is an example of the use of this approach for analyzing poverty after the Asian financial crisis.[23].Another set of papers exemplified by Cogneau and Robillard (2000) and Cororaton (2003) utilizes the household expenditure survey results to carry out microsimulations. Here each household is treated effectively as an individual economic agent and its decisions are modeled directly.

Since one of the purposes of this paper is to see if there are" generic" models of poverty analysis within the CGE family of models, I now turn to a detailed discussion and evaluation of a generic model by Stifel and Thorbecke(2003) to draw out some relevant methodological and policy lessons.

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[22] See Decaluwé, Bernard, A. Patry, Luc Savard, and Erik Thorbecke, 1999. Poverty Analysis within a General Equilibrium Framework. Working Paper No. 99-09, African Economic Research Consortium (June).

Also Dorosh, Paul A. and David E. Sahn, 2000, "A General Equilibrium Analysis of the Effect of Macroeconomic Adjustment on Poverty in Africa, *Journal of Policy Modelling* 22(6):753-776.

[23] See Azis, Iwan J.(2002), A New Approach to Modelling the Impacts of Financial Crises on Income Distribution and Poverty,Tokyo: *ADBI Research Paper* no. 35.

## 7. Poverty Analysis in a Generic CGE Model: the dual-dual Structure

It would indeed be very helpful to the applied policy analysis for poverty reduction if there could be a generic model that could be applied to a number of different policy settings in different countries. Efforts are underway, as we shall see. However, there are some serious obstacles along the way, as subsequent discussion will show. I will try to assess at the end what could be a reasonable use of such generic models.

Among the models mentioned in the previous section, the closest to being a generic model is the Stifel-Thorbecke (2003) model of an archetype African economy. They build a CGE model in order to simulate the welfare effects of trade liberalization. In particular, their effort is directed towards an analysis of the effects of trade liberalization on poverty. They use what can be called a "dual-dual" frame work (Thorbecke,1993,1994,1997). This corresponds to the characteristics of a mid-level developing economy.[24]

Briefly, the coexistence and distribution of modern and informal type of activities in both rural and urban areas are taken as basic structural features of the economy in question. According to the authors their modelling approach integrates poverty analysis with CGE proper "… by endogenizing both intra-group income distributions and the nominal poverty line". Following this line of work leads to their being able to assess policy repercussions on both poverty specific to particular socioeconomic groups and on overall national poverty.

The starting point is the dual economy models of Lewis(1954) and Fei and Ranis (1964)[25]. These pioneering efforts, however, could not or did not take into account the co-presence of dualism within each sector of the two sector models of the dual economy. Erik Thorbecke first raised this issue in 1979 during the course of a National Science Foundation interdisciplinary project on technology and development and Svejnar and Thorbecke (1982) was the first published work on a prototypical of dual-dual technology classification scheme. Khan (1982a,b) and Khan(1983) were applications of this scheme to the energy and textiles sectors in South Korea. Khan (1983) first raised the issue of linking technological dualism to poverty theoretically, following an early observation of Pyatt and Thorbecke (1976). Khan and Thorbecke(1988,1989) were further applications of technological dualism to Indonesia.

In Thorbecke's later classification a rural/urban dichotomy is combined with traditional/modern technological dualism, leading to a fourfold classificatory scheme. The four broadly defined sectors in this scheme are:

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[24] See also, Svejnar and Thorbecke (1982), Khan(1983,1985,1997). In these analyses, the particular country chosen was South Korea in the 1970s. Instead of CGE flex-price models, SAM-based models of fixed price variety were used.

[25] See Khan (1997) chs. 2 and 3 for a historical survey and a specific intertemporal dualistic model which is used to analyze the conflict between employment and output.

1. subsistence agriculture with traditional labor-intensive technologies, family farms and food crops for domestic consumption;

2. large scale agriculture producing mostly export crops using capital-intensive technology.

3. the urban informal sector defined in an operational manner;

4. modern sector with industry and services in the urban areas.

Poverty analysis in this dual-dual model proceeds along the lines developed by Decaluwé, Bernard, A. Patry, Luc Savard, and Erik Thorbecke (1999). This approach relies on varying prices and a fixed commodity basket to derive an endogenous (nominal) poverty line every time there is a shock resulting in a new equilibrium price vector for the economy. It also uses a beta distribution with varying parameters to capture differences in income distributions that are group specific. Within each group also the parameters can vary, resulting in a new distribution. Standard poverty measures are applied to pre-policy shock and post-policy shock income distributions to derive the impact on poverty. The equations of the model are as follows:

**Representation of Dual-Dual Model**

*Production and Labor Market*

$$X_{fc} = A_{fc}\overline{K}\beta_{fc}^{fc}{}_{K} LS\beta_{fc}^{fc}{}_{LS} LU\beta_{fc}^{fc}{}_{LU} \text{.....(1)} - \text{(2)}$$

$$X_{fc} = A_{ic}\overline{K}\beta_{ic}^{ic}{}_{K} LU\beta_{ic}^{ic}{}_{LU} \text{.....(3)} - \text{(4)}$$

$$i_{ic} = \frac{P_{ic}X_{ic}}{LU_{ic}} \text{.....(5)} - \text{(6)}$$

$$wu_{ex} = \frac{P_{ex}\beta_{LU}^{ex}X_{ex}}{LU_{ex}} \text{.....(7)}$$

$$wu_{ex} = i_{food}(1+\delta) \text{.....(8)}$$

$$i_{srvc} = \frac{P_{im}\beta_{LU}^{im}X_{im}}{LU_{im}} \text{.....(9)}$$

$$w_{im} = i_{srvc} + \gamma\frac{\Pi}{LU_{im}} \text{.....(10)}$$

$$\Pi = P_{im}X_{im} - i_{srvc}LU_{im} - ws_{im}LS_{im} \text{.....(11)}$$

$$wu_{ex} = (1 - \frac{hLU_{im}}{LU_{srvc} + LU_{im}})wu_{srvc} + (\frac{hLU_{im}}{LU_{srvc} + LU_{im}})wu_{im} \text{.....(12)}$$

$$ws_{fc} = \frac{P_{fc}\beta_{LS}^{fc}X_{fc}}{LS_{fc}} \text{.....(13)} - \text{(14)}$$

$$ws_{im} = \left[\frac{1-\beta_{LU}^{im}}{(1-\theta)\beta_{LU}^{im} + \theta(1-\beta_{LU}^{im})}\right]^{1/1-\theta} ws_{ex} \text{.....(15)}$$

*Disposable income and savings*

$$I_{rih} = i_{food}LU_{food} \text{.....(16)}$$

$$I_{ruh} = wu_{ex}LU_{ex} \text{.....(17)}$$

$$I_{rsh} = ws_{ex} LS_{ex} \text{.....(18)}$$

$$I_{rlh} = P_{ex} X_{ex} - ws_{ex} LS_{ex} - wu_{ex} LU_{ex} - S_{ex} \text{.....(19)}$$

$$I_{uih} = i_{srvc} LU_{srvc} \text{.....(20)}$$

$$I_{uuh} = ws_{im} LU_{im} \text{.....(21)}$$

$$I_{ush} = ws_{im} LS_{im} \text{.....(22)}$$

$$I_{ukh} = P_{im} X_{im} - ws_{im} LS_{im} - wu_{im} LU_{im} - S_{im} \text{.....(23)}$$

$$I_{bch} = tM \text{.....(24)}$$

$$S_{fc} = \lambda_{fc} [P_{fc} X_{fc} - ws_{fc} LS_{fc} - wu_{fc} LU_{fc}] \text{.....(25)} - (26)$$

*Demand*

$$C_c^h = \frac{\alpha_c^h I_h}{P_c} \text{.....(27)} - (49)$$

*Foreign Trade*

$$M = \sum_h C_{im}^h + \frac{S_{im}}{P_{im}} - X_{im} \text{.....(50)}$$

$$EX = X_{ex} - \frac{S_{ex}}{P_{ex}} \text{.....(51)}$$

*Equilibrium Conditions*

$$\sum_c LU_c = LU \text{.....(52)}$$

$$\sum_{fc} LS_{fc} = LS \text{.....(53)}$$

$$X_{ic} = \sum_h C_{ic}^h \text{.....(54)} - (55)$$

$$P_{im} \equiv 1 + t \text{.....(56)}$$

$$P_{ex} \equiv 1 \text{.....(57)}$$

The production sectors are specified as Cobb-Douglas with unitary elasticity of substitution for the two formal sector commodities in equations 1 and 2. The informal sector commodities also have Cobb-Douglas specifications. All commodities are produced under capital constraints. Thus, capital, K, in each sector has an upper bound denoted by a bar above K. The assumption that capital stock is fixed in each sector may be relaxed, but it is in fact, a fairly standard assumption for developing economies.

In the informal sectors each worker receives her average revenue product. Rural small holders may work on common land and these rural farming households may share the total income equally among all the family members. Urban informal workers supply all their labor at the prevailing wage rate. Thus leisure is not an argument in their objective function. This may be defended as an extreme assumption when people are at the margins of subsistence. Equations 5 and 6 show the informal sectors' income determination.

The total income per unit includes logically the returns also to nonlabor assets for those who own land or capital. Hence, the relevant measure of income is total income per unit from all sources.
The profit maximizing rural large landholders ensure that under competitive conditions wages for unskilled workers in the export sector are equal to the marginal revenue product of the unskilled labor they have to hire. Equation 7 reflects this condition.

Equation 8 shows the equilibrium allocation of unskilled labor in the rural informal sector. In equilibrium the rural sector wage rate is below the wage rate in the formal sector by a fixed factor. This reflects the assumption by the authors that there are transactions costs in working in the rural formal sector that is captured by this mark up.[26]

Turning now to the import sector unskilled workers in the urban area the assumption here is that they get the income per unit of labor in the urban services sector (shown in equation 9) plus a share of the profits as given in equation 10. The profit determination itself is shown in equation 11.

The Harris-Todaro model features regarding rural-urban migration are captured in equation 12. Here, in equilibrium, rural wage must equal the expected wage in the urban sector. In equation 12, the probability of getting a job in the import sector is given by the share of the urban uneducated labor force in that particular sector multiplied by a scale parameter, *h*.[27]

Skilled workers are employed only in the formal sectors. Their wages are

[26] Alternatively, one could also postulate that there is an 'insider' market wage equilibrium in the formal sector, and those unskilled workers lucky enough ( or more likely, because they know someone already working in the formal sector) to get a job in the formal sector can enjoy this wage premium. This is not a hypothesis the authors consider, but the data will be consistent with this hypothesis as well.
[27] The authors add in a footnote (footnote10) that this parameter "… permits a realistic ( i.e. lower) calibration of the probability of getting a high paying job".

determined in equations 13 and 14 by their marginal revenue products. We now turn to the determination of incomes for the households.

*Household Income Determination*:

There are nine types of households. Two in the rural area are landowning households--- large and small. There are also urban capitalists and bureaucrats. The other five are households where the main source of income is from labor.

The rural informal households which are really rural small holders receive their total revenue from production as shown in equation 16. Rural unskilled and skilled households receive their wage incomes as shown in equations 17 and 18 respectively. Equation 19 gives the incomes of the rural large land holders.

Equations 20- 24 show the incomes of the urban households. The working class households receive wage income and the capitalists the profit incomes, in general. The bureaucratic households capture part of the rents from imports by colluding with the rent seekers.[28]
The formal sector employers (rural large land owners and urban capitalists) are the only savers in the model. They each save a constant fraction of their nominal incomes.

Household demand functions are captured by maximization of Cobb-Douglas utility functions subject to their income constraints. There are 23 such equations (equations 27-49) because the four rural household groups have access to only food and importables. This gives us eight equations. Each of the urban groups has access to three commodities--- food, importables and urban services. This gives another 15 equations. The prices for the three commodities can be used to define an overall deflator.

*Foreign Trade*:

Imports in this model are the difference between domestic demand and production of import competing sector. Exports can be supplied at the prevailing price up to any quantity under the small country assumption. Thus exports are equal to total output less the savings in the form of exportables of the rural large landholders. Equations 50 and 51 show the import and export demand functions respectively.

*Equilibrium conditions for the model as a whole:*

There are two sets of equilibrium conditions in the model. First, the labor market equilibrium conditions are given by equations 52 and 53. There is disguised unemployment, as discussed before, but no formal involuntary unemployment. The second set of equilibrium condition given by equations 50 and 51 is that the domestic demand for the informal sector goods and services is matched by domestic supply.

[28] Salaries are excluded in equation 24. The reasoning is that these are invariant to exogenous shocks.

Prices in the formal sectors are set by the world market prices The export price is normalized to one. The import price is equal to 1+t, where t is the tariff rate . Exchange rate is held fixed during the particular modelling period. It is clear that the current account balance must be exogenous. In line with our discussion in the previous section, this balance is equal to foreign savings which are assumed to be zero by the authors. Hence current account balance is assumed to be zero.

*Poverty Analysis in the Generic Model:*

In order to carry out the poverty analysis, it is important to realize that the extent of poverty is unevenly spread across different households. Table 5 below gives the distribution of poor households in the model economy.

TABLE 5: FACTORIAL SOURCE OF HOUSEHOLD INCOME (%)

| | Unskilled labor | Skilled labor | Capital | Agricultural capital | Total |
|---|---|---|---|---|---|
| **Rural small holders** | 75.0 | | | 25.0 | 100.0 |
| **Rural unskilled** | 100.0 | | | | 100.0 |
| **Rural skilled** | | 100.0 | | | 100.0 |
| **Rural large holders** | | | | 100.0 | 100.0 |
| **Urban informal** | 75.0 | | 25.0 | | 100.0 |
| **Urban unskilled** | 100.0 | | | | 100.0 |
| **Urban skilled** | | 100.0 | | | 100.0 |
| **Urban capitalists** | | | 100.0 | | 100.0 |

Source: Stifel and Thorbecke(2003) Table 2.

Clearly, rural smallholders have both the second lowest average income and they have the second highest incidence of poverty. The highest incidence of poverty is found among the urban informal households. As table 5 shows they derive 75 percent of their income from wages in the unskilled labor market and 25 per cent from capital.

Table 6 below shows the initial mean incomes and population shares before the policy experiment. This table also shows the headcount measure of poverty rates for each of the household groups that earn at least some labor income. It ignores three household groups, however. The groups thus ignored are rural large landholders, urban capitalists and bureaucrats. The reason is simple. None of these households are assumed to be in poverty, nor does the particular policy shock results in poverty for any of these three groups.

TABLE 6: INITIAL INCOME AND DEMOGRAPHIC CHARACTERISTICS OF HOUSEHOLDS IN THE LABOR MARKET

| | Mean income | Population share | Percent poor |
|---|---|---|---|
| **Rural small-holders** | 1.00 | 0.59 | 83.4 |
| **Rural unskilled** | 1.05 | 0.07 | 82.5 |
| **Rural skilled** | 2.92 | 0.03 | 4.4 |
| **Urban informal** | 0.97 | 0.14 | 88.1 |
| **Urban unskilled** | 2.06 | 0.05 | 26.4 |
| **Urban skilled** | 5.85 | 0.07 | 0 |

Source: Stifel and Thorbrecke (2003) table 3

From table 6 above, it appears that the mean incomes have a wide range----from 0.97 for the urban informal workers to 5.85 for the urban skilled workers. These incomes are scaled relative to the pre-tariff import price which is the numeraire in the model. Among the skilled groups, the richest are in the urban sector. For the unskilled also, the urban unskilled group has the highest income, for reasons explained previously. Rural smallholders (60 per cent of the population) and other households with low education and skills such as rural unskilled, urban informal and urban unskilled comprise 85% of the total population and almost all of the poor come from these groups. Contrarily, households comprising of highly educated and skilled workers account for a mere 10 per cent of the total population and only 0.4% of those below the poverty line come from these groups.

For an adequate analysis of the policy impact on poverty one needs not just the information about the composition of households and their mean incomes, but also on the intragroup income distributions. As mentioned before, the statistical distribution function chosen to fit the various degrees of mean, variance, skewness and other features is the Beta Distribution. This choice allows a certain flexibility. The density functions can be either symmetric or asymmetric. They can also be skewed to the left or to the right. Of course, the choice of parameters that will result in a particular shape of the distribution function can not be arbitrary, but really should be guided by the actual shapes, or some information regarding these shapes, of the distribution functions for each particular group of households. Here, well-designed and accurate household surveys can lead to a much improved policy analysis. In this particular exercise, the assumption of within group distributional neutrality after the policy shock is maintained. Therefore, the impact on poverty comes from mainly the growth effects of the policy. A second, significant feature, however, is the urban-rural migration after the policy shock. This also affects the poverty reduction possibilities of liberalization, as we will see shortly.

*Policy Simulation in the Model and Impact on Poverty:*

According to the initial conditions postulated by the authors, at the outset 29% of the population is urban based and 71% rural based. The composition of households according to labor skills is 85% unskilled and 10% skilled. Rural smallholders are the largest group with close to 60% of the total population. Next is the urban informal with 14% of the total population. The urban skilled and rural unskilled each have 7% and the

urban unskilled and rural skilled have 5% and 3% of the total population respectively.

The production of food in the rural informal sector makes up half the total output for the entire economy. The urban informal sector produces 10% and formal sector produces 20% of the total output. Finally, the rural export sector produces another 20%.

Prior to the policy experiment of tariff liberalization, the urban skilled workers in the model economy enjoy the highest level of wages. Their wages are more than twice the level of the rural skilled, two and a half times that of the urban unskilled and more than five times that of the other three groups.

The trade policy experiment involves a tariff reduction from 40% to 20%. The obvious and immediate effect is a drop in the price of imports and a relative increase in the price of exports.[29] In keeping with the shape of the supply curves production rises for exports and falls for the import-competing sector.[30]Consistent with this, demand for both skilled and unskilled labor drops in the urban importables sector, and rises in the rural exportables sector. There is also a fall in the wages in the former sector, and a reverse migration out of this sector in the urban area to the export sector in the rural area. For this particular policy experiment, in the new general equilibrium, the share of urban skilled workers falls by 9%. At the same time the share of rural skilled workers rises by about 22%.Correspondingly, there is also a movement of the unskilled workers from the urban to the rural area as well. Finally, the fall in the aggregate income in the urban formal sector reduces effective demand for the urban services sector as well, pushing out the urban informal sector workers towards the rural area also.

Tables 7 and 8 give the results for poverty reduction. Two implicit assumptions underlie these results. First, individuals who migrate take on the socio-economic characteristics of the group in which they end up. Second, both the groups---i.e., the group from which the individual migrates and the group to which the individual worker migrates--- still have the same income distribution as before the migration.

[29] The nominal price of exports which is the numeraire remains constant.

[30] The exact extent will naturally vary with the extent of relative price changes and the supply elasticities.

TABLE 7: CHANGES IN POVERTY

| | Baseline level | Simulation (t = 0.2) | |
|---|---|---|---|
| | | Level | Change |
| **National poverty** | | | |
| **Poverty headcount ($P_0$)** | 68.92 | 68.65 | -0.27 |
| **Poverty gap ($P_1$)** | 32.91 | 32.63 | -0.28 |
| **Poverty severity ($P_2$)** | 19.53 | 19.28 | -0.25 |
| **Poverty headcount ($P_0$)** | | | |
| **Rural small-holders** | 83.40 | 82.86 | -0.54 |
| **Rural unskilled** | 82.53 | 82.09 | -0.44 |
| **Rural skilled** | 4.37 | 3.15 | -1.22 |
| **Urban informal** | 88.08 | 88.08 | 0.00 |
| **Urban unskilled** | 28.64 | 28.47 | -0.17 |
| **Urban skilled** | 0.00 | 0.00 | — |
| **Poverty depth ($P_1$)** | | | |
| **Rural small-holders** | 40.22 | 39.85 | -0.28 |
| **Rural unskilled** | 37.04 | 36.62 | -0.31 |
| **Rural skilled** | 0.45 | 0.29 | -0.03 |
| **Urban informal** | 45.27 | 45.26 | -0.01 |
| **Urban unskilled** | 4.35 | 4.33 | 0.00 |
| **Urban skilled** | 0.00 | 0.00 | — |
| **Poverty severity ($P_2$)** | | | |
| **Rural small-holders** | 23.91 | 23.63 | -0.28 |
| **Rural unskilled** | 20.52 | 20.21 | -0.31 |
| **Rural skilled** | 0.07 | 0.04 | -0.03 |
| **Urban informal** | 28.02 | 28.01 | -0.01 |
| **Urban unskilled** | 0.95 | 0.95 | 0.00 |
| **Urban skilled** | 0.00 | 0.00 | — |

Note: Poverty measures are all multiplied by 100.
Source: Stifel and Thorbecke(2003) table 7

TABLE 8: DECOMPOSITION OF CHANGES IN NATIONAL POVERTY

| Percentage contribution to total change | $P_0$ | $P_1$ | $P_2$ |
|---|---|---|---|
| **Total change** | 100.0 | 100.0 | 100.0 |
| | | | |
| **Intra-group effects** | | | |
| **Rural small-holders** | 118.7 | 78.4 | 66.4 |
| **Rural unskilled** | 11.8 | 10.8 | 9.0 |
| **Rural skilled** | 13.4 | 1.7 | 0.4 |
| **Urban informal** | 0.0 | 0.5 | 0.5 |
| **Urban unskilled** | 3.0 | 0.3 | 0.0 |
| **Urban skilled** | 0.0 | 0.0 | 0.0 |
| **Migration effect** | -53.4 | 5.7 | 21.5 |
| **Interaction effect** | 6.6 | 2.6 | 2.2 |

Source: Stifel and Thorbecke(2003 ) table 8

Under the assumptions, the results within the model show that poverty depth declines for each group. The largest drop is recorded for the rural unskilled group. Poverty severity also falls for each household group with the exception of the urban unskilled workers.

Table 8, which shows a decomposition of the changes in national poverty into the changes within the group and into the effects of migration between the groups, reveals that the decline in poverty among the rural smallholders accounts for most of the fall in national poverty. It can be recalled that about sixty per cent of the total population comes under this category. Hence, the result is to be expected. However, what could not have been anticipated is the extent by which the structure of wages and migration can dampen the poverty reduction impact of SAPs--- in this case of trade liberalization. As Stifel and Thorbecke point out:

> In the absence of migration the reduction in poverty resulting from the trade reform would have been significantly overestimated. This results from the unskilled and skilled workers losing jobs in the import sector and migrating to the rural areas where they earn much lower wages. *Note that the migration result is negative despite the fact that 1.6% of the population migrates out of the poorest socio-economic group, the urban informal sector, into the better paying export sector.(Italics added)*[31]

Although the positive effect on national poverty is still discernible, there are migrations taking place from both high paying to low paying and vice versa. The net effect is smaller than it would have been if only low paying to high paying job migration were taking place.

[31] Stifel and Thorbecke(2003), p. 232.

## 8. Conclusions and Prospects for Future Work on Asian Developing Economies

The main aspects of our survey of modelling of poverty in a CGE modelling framework can be summarized quickly. The first and second generation models included distributional questions, but did not address poverty explicitly. The third generation models do address the question of poverty reduction impact of SAPs explicitly. The main strength for poverty analysis purposes is the CGE models ability to capture the interdependence (the general equilibrium effects) in the economy. In the dual-dual formulation, the further incorporation of interdependence among the labor markets in the rural and urban sectors leads to a more realistic assessment of the poverty reduction impact of trade liberalization. However, with a few exceptions such as Azis (2002), the CGE models of the third generation still do not capture the structure of the financial markets and analyze the impact of financial liberalization on poverty reduction. There are no models in existence which try--- in the spirit of the dual-dual approach--- to reduce the dimensionality of the standard static CGE models and still retain the causal structure essential for analyzing the poverty reduction impact of financial liberalization. It will be highly desirable to attempt an exercise for financial liberalization analogous to that of Stifel and Thorbecke for trade liberalization for some representative Asian economies.

Broadly speaking, there are at least four categories of Asian economies that could be the subject of such research. First, we have low income countries of South Asia. Here, a model based on an economy such as Bangladesh could offer some insights. The second category would include middle income Asian Developing countries such as Indonesia. Here, both national and regional poverty analysis would be equally important. The third and fourth categories will include the transitional low and middle income economies. As emphasized before, the four categories are not exhaustive, but they do cover a large number including the most populous poor countries with a large number of poor people. Addressing the structural and institutional issues even in each of the four categories is beyond the scope of this paper. However, as a beginning, the case of Bangladesh can be discussed briefly here.

Bangladesh, along with India, Pakistan, PRC and Indonesia is one of the ‘big five’ in Asia in terms of both population and poverty . These five Asian countries comprise three fifths of the world’s population and two fifths of poor people. Bangladesh is a relatively homogeneous country with fairly reliable national and regional data sources. It has also been a major recipient of both program and project loans from the IFIs.

In Asian economies such as Bangladesh, the low level of income and pervasive poverty present a prima facie case for a policy focus on poverty reduction. However, there has only been mixed success in poverty reduction so far. One reason is that over the past few decades, the growth record has also been somewhat mixed. There have also been macroeconomic imbalances in the form of high fiscal deficit, low

domestic savings, and sizable external account deficit. Consequently, both inflation and interest rates were high, making the economic environment unfriendly to adequate and accelerated investment. In the wake of the policy focus on macroeconomic balancing, the growth and poverty impacts of such policies are natural candidates for rigorous investigation.

A parsimonious financial CGE model for Bangladesh with built-in capability for poverty analysis can thus be the goal of the next phase of CGE modelling for poverty analysis. In keeping with the classification scheme developed in the body of this paper, such a model could be seen as part of a new "fourth generation" of CGE models for developing economies. It will share with the third generation dual-dual models the concern for both incorporating poverty analysis in a general equilibrium framework, and to do so with as parsimonious a structure as possible. Given that there is probably considerable disguised unemployment in the rural sector and also rural-urban migration in the Harris-Todaro fashion, these features of the dual-dual model can be maintained. At the same time, work on Bangladesh can extend the dual-dual model in a minimalist fashion in at least two directions.

First, regarding the traded goods sectors, exports can be treated as both rural and urban based with different characteristics in each case. For example, both production structure and wages may be different. The second significant modification will be in the introduction of a financial sector in order to study the impacts of financial liberalization.

Within such a model, the consequences of the adjustment policies for allocation of resources, household income distribution of income and impact on poverty can be examined in a way similar to the dual-dual approach. Beginning with a solid understanding of the causality of household income distribution, flow-of-funds etc. the model will incorporate the causality of the poverty at both national and regional levels as completely as possible. The incorporation of financial SAM with important financial instruments, for instance, interest rate, required reserve ratios, and credit control will be a necessary part of the modelling process.

A properly constructed financial SAM will serve as the data-base for the financial extended dual-dual CGE model. The introduction of financial markets along with different financial assets, for example, currency, and interest-bearing deposits on loans, would specify within limits the alternative forms of assets available to the portfolios of savers. The main participants in the financial sector are the firms, households(mainly urban and upper income rural), the central bank, the banking system, and other financial institutions. Incorporation of rural-based financial institutions such as the Grameen Bank can also be carried out if data are available. Modelling these markets adequately but economically so that focus is still on poverty and the model does not become too complex will need to be the major emphasis of this work. For example, the behavior of the central bank may be specified in terms of (i) financing of government debt, and (ii) managing changes in foreign reserves, changes in money supply, required reserve ratio of the banking sector, and foreign and domestic borrowing. The domestic banking sector should be treated as fulfilling the task of financial

intermediation between the savers and the borrowers. The other financial sectors can serve as alternative sources of financing in addition to the banking sector. There are specific issues with respect to the behavior of firms such as working capital management, debt and equity structure and new investment that require close attention when finance becomes an integral part of the CGE model.

Although the first stage of the modelling process can only aim at comparative statics experiments, an eventual dynamic extension will clearly be desirable.

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**Appendix: The expanded Financial CGE Model**

Households in both agricultural and nonagricultural sectors will be further classified so as to capture the characteristics of the poor households in particular. As noted in the paper, most poor households have no or little assets, much less financial assets.

Thus, in the next phase, the household sectors will be expanded while the production and financial sectors will be compacted.

I. HOUSEHOLD AGRICULTURE (HAG)

1. $NW_{HAG}(t) = KAS_{HAG}(t-1) + DSB_{HAG}(t-1) + DPB_{HAG}(t-1) + P_Z(t)Z_{HAG}(t-1) + P^K_{HAG}(t)K_{HAG}(t-1) + S_{HAG}(t)$

Household net worth at eop (end of period) is = cash + initial deposit at private, state bank + the value of stock held at eop + value of capital, which is the amount of capital at the beginning of period multiplied by price at eop to account for capital gain + saving.

NOTE: Household Position is a net position. The assumption is that the households do not engage in borrowing activity. Household is a recipient of wages/salary, interest from deposit, and firm's profit. It does not borrow for consumption. A household may borrow for investment in a venture, however, once it takes a loan of this kind, then it no longer is classified as household. Depending on the type of business the household will be classified under a certain type of firm.

2. $QA_{HAG}(t) = NW_{HAG}(t) - P^K_{HAG}(t)K_{HAG}(t)$

Quantity of financial Assets of household Agriculture is equal to household net worth minus the value of physical capital at eop.

NOTE: Physical capital of household at eop -- $K_{HAG}(t)$ includes investment made during the year. See equations 11, 22, and 33.

3. $q_{HAG} = A^{HAG}_{SB}(i_{sb} / \bar{i}_{sb})^{\sigma_{HAG}-1} + A^{HAG}_{PB}(i_{pb} / \bar{i}_{pb})^{\sigma_{HAG}-1} + A^{HAG}_{Z}(r / \bar{r})^{\sigma_{HAG}-1} + A^{HAG}_{KAS}$

Agriculture households try to maximize the utility of return $q_{HAG}$, which is formulated using CES type harmonic mean return.

$A^{HAG}_i$ = Distribution parameter

$i_{SB}, i_{pb}$, and $r$ = interest rate at private, state bank and rate of return on capital (profit) respectively

$\bar{i}_{SB}, \bar{i}_{pb}$, and $\bar{r}$ = normal yield on bank (private and state bank) deposits and

company's capital.

$\sigma_{HAG}$ = elasticity of substitution

The agriculture household asset returns consist of interest from State Bank, Private Bank, the share of the firm's profit, and cash. Government security is not available for households to buy. Therefore there is no return from government security.

4. $\varnothing_{SB}^{HAG} = A_{SB}^{HAG} \dfrac{(i_{sb} / \bar{i}_{sb})^{\sigma_{HAG}-1}}{q_{hag}}$ → Share of deposit on state bank

5. $\varnothing_{PB}^{HAG} = A_{PB}^{HAG} \dfrac{(i_{pb} / \bar{i}_{pb})^{\sigma_{HAG}-1}}{q_{hag}}$ →Share of deposit on private bank

6. $\varnothing_{Z}^{HAG} = A_{Z}^{HAG} \dfrac{(r / \bar{r})^{\sigma_{HAG}-1}}{q_{hag}}$ → Share of equity

7. $\varnothing_{KAS}^{HAG} = A_{Z}^{HAG} \dfrac{A_{KAS}^{HAG}}{q_{hag}}$ → Share of Currency

The sum of $\varnothing_{sb}^{HAG}, \varnothing_{pb}^{HAG}, \varnothing_{Z}^{HAG}, \varnothing_{KAS}^{HAG}$ must equal to one

8. $D_{HAG} = \varnothing_{sb}^{HAG}(QA_{HAG}) + \varnothing_{PB}^{HAG}(QA_{HAG})$

Total Agriculture-household Deposit is equal to share of household deposit in state bank multiplied by total financial assets plus the share of household deposit in private bank multiplied by total financial assets.

9. $Z_{HAG} = \varnothing_{Z}^{HAG}(QA_{HAG})$

Total Agriculture-household stock/equity is share of stock x total financial assets

10. $KAS_{HAG} = \varnothing_{KAS}^{HAG}(QA_{HAG})$

Total Agriculture-household cash is share of cash x total financial assets

11. $K_{HAG}(t) = K_{HAG}(t-1) + I_{HAG}(t)$

Total Capital owned by Agriculture-household = initial capital + total investment at end of period.

II. HOUSEHOLD NON AGRICULTURE (HNAG)

12.

$$NW_{HNAG}(t) = KAS_{HNAG}(t-1) + DSB_{HNAG}(t-1) + DPB_{HNAG}(t-1) + P_Z(t)Z_{HNAG}(t-1) + P^K_{HNAG}(t)K_{HNAG}(t-1) + S_{HNAG}(t)$$

13. $QA_{HNAG}(t) = NW_{HNAG}(t) - P^K_{HNAG}(t)K_{HNAG}(t)$

14. $q_{HNAG} = A^{HNAG}_{SB}(i_{sb} / \bar{i}_{sb})^{\sigma_{HNAG}-1} + A^{HNAG}_{PB}(i_{pb} / \bar{i}_{pb})^{\sigma_{HNAG}-1} + A^{HNAG}_{Z}(r / \bar{r})^{\sigma_{HNAG}-1} + A^{HNAG}_{KAS}$

15. $\varnothing^{HNAG}_{SB} = A^{NHAG}_{SB} \dfrac{(i_{sb} / \bar{i}_{sb})^{\sigma_{HNAG}-1}}{q_{hnag}} \rightarrow$ Share of deposit on state bank

16. $\varnothing^{HNAG}_{PB} = A^{NHAG}_{PB} \dfrac{(i_{pb} / \bar{i}_{pb})^{\sigma_{HNAG}-1}}{q_{hnag}} \rightarrow$ Share of deposit on private bank

17. $\varnothing^{HNAG}_{Z} = A^{HNAG}_{Z} \dfrac{(r / \bar{r})^{\sigma_{HNAG}-1}}{q_{hnag}} \rightarrow$ Share of equity

18. $\varnothing^{HNAG}_{KAS} = A^{HNAG}_{Z} \dfrac{A^{HNAG}_{KAS}}{q_{hnag}} \rightarrow$ Share of Currency

The sum of $\varnothing^{HNAG}_{sb}, \varnothing^{HNAG}_{pb}, \varnothing^{HNAG}_{Z}, \varnothing^{HNAG}_{KAS}$ must equal to one

19. $D_{HNAG} = \varnothing^{HNAG}_{sb}(QA_{HNAG}) + \varnothing^{HNAG}_{PB}(QA_{HNAG})$

20. $Z_{HNAG} = \varnothing^{HNAG}_{Z}(QA_{HNAG})$

Total Nonagricultural-household stock/equity is share of stock x total financial assets.

21. $KAS_{HNAG} = \varnothing^{HNAG}_{KAS}(QA_{HNAG})$

Total Non-agriculture-household cash is share of cash x total financial assets

22. $K_{HNAG}(t) = K_{HNAG}(t-1) + I_{HNAG}(t)$

Total Capital owned by Non-agriculture-household = initial capital + total investment at end of period.

III. HOUSEHOLD TOTAL (h)

23. $NW_h(t) = NW_{HAG}(t) + NW_{HNAG}(t)$

24. $QA_h(t) = QA_{HAG}(t) + QA_{HNAG}(t)$

25. $qh = q_{HAG} + q_{HNAG}$

26. $\varnothing_{SB}^{h} = Q_{SB}^{HAG} + Q_{SB}^{HNAG}$ → Share of deposit on state bank

27. $\varnothing_{PB}^{h} = Q_{PB}^{HAG} + Q_{PB}^{HNAG}$ → Share of deposit on private bank

28. $\varnothing_{Z}^{h} = Q_{Z}^{HAG} + Q_{Z}^{HNAG}$ → Share of equity

29. $\varnothing_{KAS}^{h} = Q_{KAS}^{HAG} + Q_{KAS}^{HNAG}$ → Share of Currency

30. $D_h = D_{HAG} + D_{HNAG}$

31. $Z_h = Z_{HAG} + Z_{HNAG}$

32. $KAS_h = KAS_{HAG} + KAS_{HNAG}$

33. $K_h(t) = K_{HAG}(t) + K_{HNAG}(t)$

IV. FIRMS

34 - 37. $DEF = P_i^k I_i - S_i$ i = FAG, FMIN, FTS, FI

38-41. $Z_i(t) = Z_i(t-1) + \alpha_i + \beta_i\left[(DEF_i(t) / P_i^k(t)\right]$ i = FAG, FMIN, FTS, FI

42-45.

$$QL_i(t) = DEF_i(t) - P_z(t)\left[Z_i(t) - Z_i(t-1)\right] + LSB_i(t-1) + LPB(t-1) + LF_i(t-1)$$

i = FAG, FMIN, FTS, FI

Another part of the deficit must be financed through borrowing. The required amount of total borrowing at time t $(QL_i(t)$ must be equal to the amount of deficit minus the value of outstanding equity increase at the end of period plus last year's outstanding loan from state bank, private bank, and foreign loan.

The firm's total loan comes from different sources. From the State Bank, Private Bank, and from foreign loan, with distribution parameter of $A_x^i$, and interest rate on bank loan of $i_l$, interest rate of foreign loan of $i_f$. Using CES specification, the firms try to minimize the cost function based on capitalized borrowing cost of $\bar{i}_{xi} / i_x$.

46.-49. $q_i = A_{sb}^i(\bar{i}_{li} / i_l)^{\sigma_i - 1} + A_{pb}^i(\bar{i}_{li} / i_l)^{\sigma_i - 1} + A_{fl}^i(\bar{i}_{fli} / i_{fl})^{\sigma_i - 1}$

i = FAG, FMIN, FTS, FI

$q_i$ is the average of capitalized interest rates for each type of the firm.

NOTE: It is assumed that interest rate is not the explaining factor for the firm's decision to choose between state bank or private bank. The image of private bank as having better service, faster and easier to deal with and that of state bank as safer, bigger, more helpful when a firm is in trouble is important and may determine in the short run the selection of such a bank for financing. However, firms borrowing from the State bank are restrained by many requirements and its reputation for inflexibility must be taken into account when one tries to find out why there are certain preferences toward state or private bank financing.

The share of loan from state bank, private bank, and foreign loan of each firm is given by equation 50-61. The sum of the share must equal to 1.

50-53. $\varnothing^i_{sb} = A^i_{sb} \dfrac{(\bar{i}_{Li} / i_l)^{\sigma_i - 1}}{q_i}$ i = FAG, FMIN, FTS, FI

54-57. $\varnothing^i_{pb} = A^i_{pb} \dfrac{(\bar{i}_{li} / i_l)^{\sigma_i - 1}}{q_i}$ i = FAG, FMIN, FTS, FI

58-61. $\varnothing^i_{lf} = A^i_{lf} \dfrac{(\bar{i}_{fli} / i_{fl})^{\sigma_i - 1}}{q_i}$ i = FAG, FMIN, FTS,FI

The demand for loan from each type of bank by each type of firm is given in equation 62 to 73.

62-65. $LSB_i = \varnothing^i_{lsb} QL_i$ i = FAG,FMIN,FTS, FI

Firm's demand for loan from state bank

66-69. $LPB_i = \varnothing^i_{lpb} QL_i$ i = FAG,FMIN,FTS,FI

Firm's demand for loan from private bank

70-73. $LF_i = \varnothing^i_{lf} Ql_i$ i = FAG,FMIN,FTS,FI

Firm's demand for loan from abroad

74. $L = \sum_{i=FAG}^{FI} LSB_i + \sum_{i=FAG}^{FI} LPB_i$

Total domestic loan = total loan from state bank and from private bank to all firms.

75-78. $K_i(t) = K_i(t-1) + I_i(t)$ $K_i$ (t) = $K_i$ (t-1) + $I_i$ (t)

Total capital stocks held by firms at the end of period equal to capital stock at

the beginning plus investment at the end of period.

V. GOVERNMENT (G)

79. $FL_G(t) = FL_G(t-1) + e(\Delta FL_G^{\$})$

Foreign Loan at time t (eop) = Outstanding Loan from abroad at the beginning plus New Loan from abroad in local currency. The additional loan amount is exogenous, valued at foreign currency (dollar) but converted into local currency by multiplication with exchange rate.

80. $QL_G = LPB_G(t-1) + LSB_G(t-1) + LCB_G(t-1) + P_G^k(t)I_G(t) - S_G(t) - e(\Delta LF_G^{\$})$

Government Demand for domestic credit = Govt. Investment + initial borrowing from the banking system (SB, PB, and CB), less Government Saving and Loan from abroad.

NOTE: The Government demand for domestic credit is a net position with loan payment included (if any). Any amount of loan repayment from the government to the banking system will appear as reduction in saving by the same amount. Government investment is exogenous.

81. $L_G = \left[\alpha_G^{SB} + \beta_G^{SB}(DEP_{SB})\right] + \left[\alpha_G^{PB} + \beta_G^{PB}(DEP_{PB})\right]$

Bank Credit to Government = initial claims of government, certain resources in SB and PB + statutory liquidity ratio $\beta$ multiplied by Deposit of SB and PB.

82. $LCB_G = QL_{G-}L_G$

Central Bank Loan to Government; it is the government balance sheet residual i.e. the portion of total loan to government that is not fulfilled by commercial banking sector.

83. $K_G(t) = K_G(t-1) + I_G(t)$

VI. COMMERCIAL STATE BANK PORTFOLIO (SB)

84. $DSB = DSB_{HAG} + DSB_{HNAG}$

Deposits in the state bank come from household, agriculture and non-agriculture, at a fixed rate of deposit $i_d$.

85. $RR_{SB} = u_1^{SB} + u_2^{SB}(DEP^{SB})$

Reserve requirement in the central bank = marginal amount $u_i$ + a fraction of deposits.

86. $QL_{SB} = DSB + ADVCB_{SB} - LSB_G - RR_{SB} + LIK_{SB}$

Domestically available resources or the total loan can be given from domestic resources = deposit + advances from central bank + liquidity credit from central bank - loan to Govt. - reserve requirement.

87. $DCB_{SB} = RR_{SB}\left[1 + \theta(i_{lsb} / \bar{i}_l)^{-\gamma}\right]$

The State Bank reserve at the central bank is always higher than the requisite reserve requirement. The excess reserve is a function of interest rate charged by the state bank for loan. The higher the rate the lower the excess reserves.

88. $LF_{SB} = \left(L_G^{SB} + DCB_{SB} + \sum_{i=FAG}^{FL} LSB_i\right) - (DSB - REDSCNT - NW)$

The state bank resources are deposits, rediscount from the central bank and net worth. The total resources available will be used to create loans to government; commercial loans to firms and some will be used as deposits to central bank. If the available resources are less than the loan created, then foreign loan is needed.

VII. COMMERCIAL PRIVATE BANK PORTFOLIO (PB)

89. $DPB = DB_{HAG} + DPB_{HNAG}$

90. $RR_{PB} = u_1^{PB} + u_2^{PB}(DEP^{PB})$

91. $QL_{PB} = DPB + ADVCB_{PB} - LPB_G - RR_{PB} + LIK_{PB}$

Available resources (domestic) = deposit + advances from central bank - loan to Govt. - reserve requirement + liquidity credit from central bank

92. $DCB_{PB} = RR_{PB}\left[1 + \theta(i_{lpb} / \bar{i}_l)^{-\gamma}\right]$

93. $LF_{PB} = \left(L_G^{PB} + DCB_{PB} + \sum_{i=FAG}^{FL} LPB_i\right) - (DPB - REDSCNT - NW)$

VIII. COMMERCIAL BANK TOTAL

94. $DEP = DSB + DPB$

Total deposit taken by commercial bank.

95. $RR = RR_{SB} + RR_{PB}$

Total reserve deposit at central bank.

96. $QL + QL_{SB} + QL_{PB}$

Total resources are available domestically.

97. $i_L = \bar{i}_L \left[ \frac{L(i / i_F)^{\in} (i_R / i_R)^{\phi}}{\alpha QL} \right]^{1/\delta}$

Market clearing interest rate $i_L$ = Loan interest rate; $i_F$ =Foreign Loan interest rate; $i_R$ = Rediscount Interest rate.

$\in, \phi,$ and $\delta$ = loan supply interest rate elasticities, $\alpha$ = loan supply intercept.

98. $DCB = DCB_{SB} + DCB_{PB}$

Total deposit of commercial bank at central bank, is including required reserve.

99. $LF = LF_{SB} + LF_{PB}$

Total residual items. The foreign loan needed by the domestic commercial banking sector to cover excess loan over domestic resources available.

IX. CENTRAL BANK PORTFOLIO

100. $FL = FL_{SB} + FL_{PB} + FL_{FAG} + FL_{MIN} + FL_{IS} + FL_I + FL_G$

101. $ADVCB = ADV_{CEL} + \varnothing_4 \left[ (FL_{SB} + FL_{PB}) - FL_{CEL} \right] - \gamma_4 (DEPCB - RR)$

Total advances available from central bank = ceiling for advances less state bank's and private bank's advances, less net deposit at central bank.

102. $KAS_{CB} = KAS_H$

103. $NWCB(t) = NWCB(T-1) + DISCR$

DISCR = Accounting discrepancy of state owned firms

104. $CBREV(t) = FL(t) - FL(t-1) - SF(t) + CBRES(t-1)$

Central Bank's reserve = net foreign loan at eop less foreign saving plus reserve at the beginning of the period.

105. $NWRES = CBLG + ADVCB + CBRES - KASCB + DEPCB - NWCB$

X. OTHER FINANCIAL BALANCE

106. $P_Z = \dfrac{ZZ_H}{(Z_{FAG} + Z_{MIN} + Z_{FTS} + Z_I}$

107. $INT = \left(A_{SB}^H + A_{PB}^H + i_L L_{SB} + i_L L_{PB}\right) + \left(A_{CB}^{SB} + A_{CB}^{PB} + i_L L_{SB} + i_L L_{PB}\right)$

Interest payment.

XI. PRODUCTION AND PRICE FORMATION

108 - 114. $P_i^k = \xi_4 P_4 + \xi_7 P_7$` i = 1,2,3,4,5,6,7

$P_i^k$ = Price indexes for each sector's capital stock; capital goods come from the industrial sector and from import.

115 - 121
$$P_{i0}^* = [(\Theta_{1i})^{\sigma_i^{\text{int}}} (P_1)^{1-\sigma_i^{\text{int}}} + (\Theta_{2i})^{\sigma_i^{\text{int}}} (P_2)^{1-\sigma_i^{\text{int}}} + (\Theta_{3i})^{\sigma_i^{\text{int}}} (P_3)^{1-\sigma_i^{\text{int}}} + (\Theta_{5i})^{\sigma_i^{\text{int}}} (P_5)^{1-\sigma_i^{\text{int}}} + (\Theta_{6i})^{\sigma_i^{\text{int}}} (P_6)^{1-\sigma_i^{\text{int}}} + (\Theta_{7i})^{\sigma_i^{\text{int}}} (P_7)^{1-\sigma_i^{\text{int}}}]^{1/(1-\sigma_i^{\text{int}})}$$

i = 1,2,3,4,5,6,7; $P_{i0}^*$ = cost indexes for sectoral intermediate uses, input output coefficient = $a_{ji}^*$ and constant elasticities of substitution among intermediate inputs = $\sigma_i^{\text{int}}$

122 - 128. $a_{ji}^* = \left[\dfrac{P_i^* \Theta_{ji}}{P_j}\right]^{\sigma_i^{\text{int}}}$ j =Sector; i= Market participant HAG - FI

$a_{ji}^*$ = Input Output Coefficient.

129 - 135.
$$P_i^c = \left[(\Theta_{Li})^{\sigma_i^{FIN}} (W_i)^{1-FIN} + (\Theta_{Ki})^{\sigma_i^{FIN}} (r_i + \delta_i)(P_i^K)^{1-FIN}\right]^{1/(1-\sigma^{1-FIN})} + (\Theta_i^*)^{\sigma_i^{FIN}} (P_i^*)^{\sigma_i^{FIN}}$$

CES Cost function = labor cost + fixed capital cost + cost of intermediate goods used

i = sector/commodity 1-7

$\sigma_i^{FIN}$ = Elasticities of substitution

136 - 142. $L_i = (P_i^c \Theta_{Li} / W_i)^{\sigma_i^{FIN}} X_i$ i = Hag - FI

Level of employment.

143 - 149. $r_i(t) = \frac{1}{P_i^K(t-1)}\left[ P_i^c(t)\Theta_{Ki}\left( \frac{X_i(t)}{K_i(t-1)} \right)^{1/\sigma_i^{INT}} \right] - \delta_i$

Sectoral rates of profit are determined by output level X and incoming capital stocks $K_i(t-1)$

i = HAG - FI

150. $r(t) = \frac{r_{HAG}(t)P_{HAG}^K(t)K_{HAG}(t-1) + \cdots r_{FI}(t)P_{FI}^K(t)K_{FI}(t-1)}{P_{HAG}^K(t)K_{HAG}(t-1) + \cdots P_{FI}^K(t)K_{FI}(t-1)}$

Average rate of profit (used for household portfolio decisions) depends on sectoral rate of profit

151 - 157. $X_{ji} = a_{ji}^* \left[ \frac{P_i^c \Theta_i^c}{P_i^c} \right]^{\sigma_i^{FIN}} X_i$ j = Commodity 1 - 7

i = Market Participant HAG - FI

Intermediate goods flow using $a_{ji}^*$ coefficient of input output defined with regard to the intermediate aggregate. (Flow of goods j (sector j ) to market participant i; i.e. demand of good j by market participant i).

158 - 164. $Mi = \left[ \frac{P_i \Theta_{0i}}{e(1+t_0)P_0} \right]^{\sigma_i^{FIN}} X_i$

i = Sector 5, 6 & 7 (Import Mining and Import other)

*Mi* = Derived demand for import

165 - 171. $P_i = P_i^c(1-t_i)$ i = 1-7

After tax prices for each sectors/commodity

XII. INCOME GENERATION AND SAVING

172. $W = w_{HAG}L_{HAG} + \cdots w_{FI}L_{FI} + W_{fh} - W_{hf}$

173 - 179. $\Pi_i(t) = r_i(t)P_i^K(t)K_i(t-1) + \Pi_{fi} - \Pi_{if}$

i = HAG, HNAG, SB, PB, FAG, FMIN, FTS,FI.

Profit income flows.

180 - 185. $OS_i = (1-\upsilon_i)\Pi_i + SUB$ i = SB, PB, FAG, FMIN, FTS,FI.

Operating surplus of firms i is part of profit after the household share of $\upsilon$
Government owned firm (Bank) receives subsidy $SUB$

186 - 191. $S_i = (1-d_i - t_i^{dir})OS_i$ i = SB, PB, FAG, FMIN, FTS,FI

Saving of the firm, equal to operating surpluses less dividend $d$ payment less direct taxes $t_i^{dir}$.

192. $Y_{HAG} = W_{HAG} + d_{SB}^{HAG} OS_{SB}^{HAG} + \cdots d_{FI}^{HAG} OS_{FI}^{HAG} + v_{SB}^{HAG} \Pi_{SB}^{HAG} + \cdots v_{FI}^{HAG} \Pi_{FI}^{HAG} + TRAN_{gHAG} + TRAN_{fHAG}$

Household AG income = wages +dividend + share of profit +transfer from G and abroad.

193. $Y_{HNAG} = W_{HNAG} + d_{SB}^{HNAG} OS_{SB}^{HNAG} + \cdots d_{FI}^{HNAG} OS_{FI}^{HNAG} + v_{SB}^{HNAG} \Pi_{SB}^{HNAG} + \cdots v_{FI}^{HNAG} \Pi_{FI}^{HNAG} + TRAN_{gHNAG} + TRAN_{fHNAG}$

194. $Y_h = Y_{HAG} + Y_{HNAG}$

Total HH income is the sum of HAG Income and HNAG income

195. $D_{HAG} = D_0^{HAG} + (1+s_{HAG})Y_{HAG} - TRAN_{HAGf} - t_{HAG}^{dir} Y_{HAG} - (A_5^h + i_L L_5) + Y_{HAG} NW_{HAG}$

Consumption demand = initial /basic consumption + consumption - transfer abroad - direct taxes

196.
$D_{HNAG} = D_0^{HNAG} + (1+s_{HNAG})Y_{HNAG} - TRAN_{HNAGf} - t_{HNAG}^{dir} Y_{HNAG} - (A_5^h + i_L L_5) + Y_{HNAG} NW_{HNAG}$

197. $D = D_{HAG} + D_{HNAG}$

198. $S_{HAG} = Y_{HAG} - TRAN_{HAGf} - t_{HAG}^{dir} Y_{HAG} - (A_f^{HAG} + i_L L_5) - D_{HAG}$

199. $S_{HNAG} = Y_{HNAG} - TRAN_{HNAGf} - t_{HNAG}^{dir} Y_{HNAG} - (A_f^{HNAG} + i_L L_5) - D_{HNAG}$

200. $S_h = S_{HAG} + S_{HNAG}$

201. $Y_g = \sum_{i=1}^{4} t_i P_i^c X_i + et_0 P_5 M_5 + et_0 P_6 M_6 + et_0 P_7 M_7 + t_h^{dir} Y_h + \sum_{i=SB}^{FI} t_i^{dir} OS_i + \sum_{i=1}^{4} t_i^{\exp} P_i^c E_i$

t

Government income consists of the sum of indirect taxes from all sectors + domestic currency of import indirect taxes + direct taxes from household + the sum of direct

taxes of firms + export taxes.

202. $S_g = Y_g - \sum_{i=1}^{7} P_i G_i - TRAN_{gh} - (A_5^g + i_l L_g)$

203. $S_f = \sum_{i=1}^{7} \Pi_{if} + W_{hf} + \sum_{i=5}^{7} eP_i M_i + TRAN_{hf} + TRAN_{gf} - \sum_{i=1}^{4} (1 + t_i^{\exp}) P_i^c E_i - W_{fh} - \sum_{i=1}^{4} \Pi_{fi} - TRAN_{fg} - TRAN_{fh}$

Current Account Deficit in foreign currency terms is converted to domestic currency, with export tax rate of $t_i^{\exp}$

XIII. FINAL DEMAND DETERMINATION

204. $\tilde{D} = \sum_{i=1}^{7} \Theta_i^{dem} P_i$ i = 1-7

205 - 211. $C_i = \Theta_i^{dem} + (\alpha_i^{dem} / P_i)(D - \tilde{D})$

i = 1-7

212 - 215. $I_i(t) = \left[ I_{0i} + \omega_i \left\{ r_i(t) - i_l(t) \right\} \right] K_i(t-1)$

i = firms ;FAG - FI.

Investment demands of firms depend positively on rate of profit $r_i$ and negatively on loan interest rate $i_l$. The firm investment parameter is $\omega_i$.

216 - 217 = $I_i(t) = \left[ I_{0i} + \omega_i \left\{ r_i(t) \right\} \right] K_i(t-1)$ i = SB and PB

State bank and private bank demand for investment depend positively on the rate of profit. The Investment demand, loan rate and deposit rate is negative and positive respectively. However, a simultaneous increase in the loan and deposit rate will net a zero effect. The decisive factor in this case is the spread between loans - deposit rate. But the spread will correlate with rate of profit thus the spread effect on investment demand has been reflected through the inclusion of $r_i$.

218. $I_{HAG} = I_{0HAG} + \omega_{HAG}^i i_l + \omega_{HAG}^y (Y_{HAG} / P_{HAG}^k)$

219. $I_{HNAG} = I_{0HNAG} + \omega_{HNAG}^i i_l + \omega_{HNAG}^y (Y_{HNAG} / P_{NHAG}^k)$

220. $I_h = I_{HAG} + I_{HNAG}$

Household demand for investment is a function of interest rate (with investment parameter $\omega^i$) and real income (investment parameter $W^y$).

221. $I_g = I_{0g}$

222 - 225. $E_i = E_{0i}\left[\frac{eP_f^E}{(1+t_i^{Exp})P_i^c}\right]^{\eta}$

Export depends on the ratio of price of foreign goods and domestic border price, the elasticity is $\eta$. i = 1-4

XIV. COMMODITY BALANCES

226 - 232. $Xi = \sum_{j=HAG}^{FI} X_{ij} + C_i + G_i + \xi_i(\sum_{j=HAG}^{FI} I_j) + p_i\left[\sum_{i=1}^{7} \delta_i K_i(t-1)\right]$

i = Commodity 1-7; j = HAG - FI

$p_i$ = sectoral composition of depreciation

XV. SAVING - INVESTMENT BALANCE

233. $SI = \sum_{i=HAG}^{FI} S_i + S_f - \sum_{i=HAG}^{FI} P_i^k I_i$

Saving of all sectors (excluding the G) plus foreign saving less investment of all sectors (foreign saving not included) will be zero if overall macroeconomics balance is to be maintained.