A Review of Macro Modelling in Ethiopia
(With Lessons from Published African Models)

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A Review of Macro Modelling in Ethiopia
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Abstract

This paper examines the main features of African (and Ethiopian) macro models, with aim of developing an applied macro model for Ethiopia. Since applied macro modelling in Africa is largely informed by the IMF and World Bank models, a detailed discussion of the theoretical underpinning of these models is done. This is followed by a brief review of a number of published macro models of Africa, with the aim of examining the main features emphasised in these models. The paper then examined both academic and applied macro models in Ethiopia. Noting the paucity of macro models in Ethiopia, the paper concludes that current events call for developing an applied macro model and its institutionalization. Such a model could serve as an invaluable instrument for policy making and can be used in a sustainable manner if it is properly institutionalized.

Key Words: Macro Modelling, Econometric Modelling, Macro Policy, Developing countries, Africa, Ethiopia.

I. Introduction:

This paper examines some of the main features published African macro models in general and that of Ethiopia’s in particular. The analysis is primarily conducted with the objective of understanding the theoretical underpinning of macro models built (and/or used) in Africa. The paper is motivated by an attempt to build an applied macro model for Ethiopia. This requires an examination of current applied macro models in Africa. The majority of African countries are using the World Bank (WB) and the International Monetary Fund (IMF) models since these two institutions play a greater role in macro policy making in Africa. Thus, section two of the paper makes a detailed presentation of the theoretical underpinning of the Fund and the Bank models.

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The paper is organized as follows. In section two the IMF’s ‘Financial Programming Model’ and the WB’s ‘Revised Minimum Standard Model’ (RMSM) are discussed. In section three, a number of published African macro models will briefly be reviewed. The section aims at examining the main features emphasized in these models. In Section four, a review of macro models (both academic and applied) in Ethiopia is made. Section five, by outlining the need for applied macro model, concludes the paper.

II. The Bank and the Fund Models for Developing Countries

2.1 Growth/Adjustment as policy option in an Open economy

The macroeconomics of open dependent economies is approached from different perspective. However, most of the emphasis is on adjustment (to different shocks), macro stability and growth. One of the intellectual traditions in this respect is the approach of the WB and the IMF which turned out to be the basis for macroeconomic policy making in developing countries. The approach of the Bank and the fund is summarized below based on the work of Khan, Montiel and Haque (1990).

According Khan et al (1990) the Bank and the Fund's programmes have complementarity. The structure of the Fund's programme is laid on a framework that links the financial sectors with the balance of payment - termed as the 'monetary approach to the balance of payment'. The Bank's approach is based on the two-gap or Harrod Domar growth model for open economies - defined as the 'Revised Minimum Standard Model (RMSM)' by the Bank (Khan et al, 1990:156). Their complementarity emerges from the fact that the Bank emphasizes the real while the Fund the financial sides of the economy. Since these two approaches informed applied macro models in Africa, Ethiopia included, we have discussed them in detail below.

The Khan et al (1990) model assumes an economy that is divided into four sectors: private, public, foreign and domestic banking. The private sectors budget constraint is given as

\[ Y - T - C_p - \Delta K \equiv \Delta M + \Delta F_p - \Delta D_p \]  

where Y is nominal income, T taxes, C consumption, K investment, M money, F foreign asset, D borrowing from the banking system and subscript p the private sector. On the other hand the public sector's (g) revenue (T) and spending (Cg) is related to the possibility of deficit or surplus as given by equation [2],

\[ T - C_g \equiv \Delta F_g - \Delta D_g \]  

The foreign sector has revenue from imports (Z) and spends it on exports (X). Any imbalance is adjusted by purchase of liabilities (or assets) with an effect on the reserve level of domestic banks (R) leading,

\[ Z - X \equiv - (\Delta F_p + \Delta F_g + \Delta R) \]  

The above transactions will result in the supply of money given as
\[ \Delta M \equiv \Delta R + \Delta D_p + \Delta D_g \]  \hspace{1cm} [4]

Equations 1 - 4 result in
\[ Y - C_p - \Delta K - C_g - X + Z \equiv 0 \]  \hspace{1cm} [5]

Equation [5] is a familiar national accounting identity which is basic for the analysis of the Bank's and the Fund's approach (Khan et al., 1990: 155-158).

2.2 The Fund (the IMF)

The objective of the Fund is to finance temporary balance of payment problems. The model relevant for this – called financial programming - is developed by Polak (1957) and Robichek (1967). As is explicitly demonstrated by Khan et al. (1990) the Fund’s approach rests on three fundamental assumptions. First, real GDP is assumed to be exogenously given,

\[ Y = P \bar{y} \]  \hspace{1cm} [6]

where \( P \) denotes the domestic price level and \( \bar{y} \) real GDP. The change in nominal GDP is given by,

\[ \Delta Y = \Delta P \bar{y}_{t-1} + P_{t-1} \Delta \bar{y} \]  \hspace{1cm} [7]

Second, the income velocity of money (\( v \)) is assumed to be constant,

\[ \Delta M^D = v^{-1} \Delta Y \]  \hspace{1cm} [8]

where \( M^D \) is the demand for money.

Third, the money market is specified as a flow-equilibrium:

\[ \Delta M^S = \Delta M^D = \Delta M \]  \hspace{1cm} [9]

where \( M^S \) is the money supply. These formulations combined with equation 4 of the general framework result in one of the fundamental equation of the ’monetary approach to the balance of payment’ which relates policy variables (marked \( \hat{\cdot} \)) with the balance of payment (\( \Delta R \)) as

\[ \Delta R = v^{-1} \Delta P \bar{y}_{t-1} + v^{-1} P_{t-1} \Delta \bar{y} - (\Delta \hat{D}_p + \Delta \hat{D}_g) \]  \hspace{1cm} [10]

Here, ‘the balance of payment is expressed as the difference between the private sector’s flow demand for money and the flow of domestic credit’ (ibid.:159). The balance of payment is, thus, directly linked to the domestic credit level. Hence, this equation is used as "a rationale for the use of credit ceiling as performance criteria in the Fund’s programs" (ibid.:160).

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1 See Khan et al (1990) pages 160-163 for a possibility of a unique solution by endogenizing the price level.
The nature of the demand for money and the assumption of constant velocity are crucial in this approach. Although the latter is questioned, empirical studies are cited to support its stability (ibid.:160). The other important component of the Funds policy framework (following credit ceiling) is a sub- ceiling on the expansion of credit to non-financial public sector. Thus, the public sector, as instrument of policy, must adjust to the targeted credit expansion to the private sector either by increasing its revenue or reducing its expenditure (ibid.:164). The implicit assumption in such an approach is that the private sector can easily accommodate any external shock (see Fitzgerald and Sarmad, 1990 for the critique, however).

2.3 The Bank (the World Bank)

Unlike the Fund, the Bank is concerned with the financing of growth (and hopefully development) over the medium term and hence emphasizes savings, foreign capital inflow, investment and growth. This is articulated in the Bank’s RMSM (and its recent variant RMSM-X (XX)… models). The RMSM remained the most widely used model by developing countries. Being an accounting framework the RMSM links national accounts with the balance of payment emphasising on financing of gaps and projection of foreign borrowing. In this sense it adheres to the basic accounting relationship used in an open economy macroeconomic analysis.

The RMSM has four basic building blocks:

1. ICOR (Incremental Capital Output Ratio, \( \rho \)) is given; and output is a function of investment, \( \Delta K \).

\[
\Delta y^* = \rho \Delta K
\]

[11]

This helps to determine either the desired level of investment, for a given (targeted) level of growth or vice versa.

2. Exports are assumed to be determined exogenously.

3. Stable relationship between GDP \( y^* \) and imports \( Z \) is assumed: \( Z=ay^* \). \( (a \) being a parameter)

4. It is further assumed that there exists a stable, historically given, saving rate leading to a consumption function of the form:

\[
C_p = (1 - s)(y^* - \hat{T}).
\]

[12]The assumption of fixed ICOR is unrealistic in the light of many empirical studies (see Chenery et al, 1986: 230-232). However, the above set up, combined with the equation which summarizes the general framework (equation 4) gives the equation which equates domestic investment with private, public and foreign saving as,

\[
\Delta K = (y^* - \hat{T} - C_p) + (\hat{T} - \hat{C}_s) + (Z - X).
\]

[13] Substituting the import demand and the consumption function in the above equation and taking exports as exogenous, we can have an alternative to the general equation (equation 5) given by:
\[ \Delta K = s(y^* - \hat{T}) + (\hat{T} - \hat{C}_g) + (a y^* - \bar{X}) \]
\[ = (s + a)y^* + (1 - s)\hat{T} - \hat{C}_g - \bar{X}. \]  

From the supply (technological) side investment is positively related to output as,

\[ \Delta K = \rho y^* - \rho y_{-1}, \]  

In the simultaneous determination of these two equations (equations 14 and 15) the level of investment and income is determined in the Bank model. We note further that there are two policy options to raise saving: reduction of public consumption and increased taxation (since taxation’s impact in reducing private saving is assumed to be small, for consumption level will also be lowered). However, the model implies that targeted growth and balance of payment can be maintained if only some sort of control over foreign finance is there, as

\[ \Delta \hat{F} = \bar{X} - ay^* - \Delta R^* \]  

If there is a limit on foreign finance, then, the output determination equations above will be constrained. This will lead to the strand of the literature referred as the gap models (see Chenery & Strout 1966, Bacha 1990, Taylor 1991 among others). This formulation made the RM SM a helpful tool in determining and projecting the growth consequence of different level of finance (or the required finance for a stipulated growth).

Finally, the two approaches are merged in the works of Khan et al (1990). The merging proceeds first by deriving the growth of real output from the ICOR relationship (which is crucial in the Bank approach). The expression for investment is derived from the budget constraint of the private sector (using the consumption function defined). Retaining the Fund's assumption of exogenous income velocity and the supply of money coming from the banking system's balance sheet (equation 4), the flow equilibrium of the money sector is defined. These relationships are further combined with the conditions of the external sector. The external sector's budget constraint helps to define the balance of payment where its components (exports and imports) are further defined. Exports are assumed to depend on relative prices; foreign financial flows are taken to be exogenously determined; and finally imports are assumed to depend on income and relative prices (See Khan et al, 1990: 170-172; Agenor 2000 for detail).

The conclusion that the authors drew from this exercise is that when the two approaches are linked, growth, inflation and balance of payment can be endogenized. This in trun implies that monetary, fiscal and exchange rate policies can be used (although the Bank approach is closer to the two gap model while that of the Fund’s leans towards the 'monetary approach to the balance of payment') as policy instruments to achieve growth and adjustment objectives. Khan et al (1990) underlined that financial aspects are unduly emphasised compared to the relative neglect of the models to realistically include the monetary sector (like interest rate, curb markets, bonds and the like). More importantly the models also neglect the impact of cost factors (like wage) which could possibly nullify the policies designed, and hence, they recommend further research in this direction.
This preliminary attempt to combine the two has also been further carried in the Khan and Montiel (1989)\(^2\). The essential of this work is, as the previous one, to combine the balance of payment with an open economy neoclassical growth model. This new model is similar to the previous one (ie., Khan et al, 1990). It differs in that first it doesn't utilise restrictive assumptions about the growth process, foreign debt and debt service or the endogeneity of exports. Second, the model links the objectives of adjustment to a variety of government policies. Third, it can be used to trace the effect of changes in external financing on monetary and real variables in the economy (Khan et al, 1987: 281). Since there is no fundamental difference between the two models we do not discuss the detail of this model here. The policy implication of these models is to prescribe the 'Structural Adjustment Package, which can readily be extracted from the modelles discussed above and informed the Bank’s and the Fund’s policy in developing countries.

The growth and adjustment link described above has been critically evaluated for the past two decades by different schools of though in the profession. The critics embody the proposition that the relative neglect of the role of institutional and unique conditions in each developing country would result in an unexpected result of the policies pursued. Writing on those issues, Taylor (1989) stated that 'devaluation may cause output contraction; tight money may lead to price increases due to higher interest costs; inflation is likely to have its internal dynamics; and public investment may crowd-in private capital formation in instead of out'. In the long run, the critics emphasis the importance of income distribution in conditioning the growth process. They are also sceptical of the virtue in liberalization and unfettered external capital flow and trade. They also stress that policies would be futile unless they are designed paying heed to such aspects (Taylor, 1989: 4). These critics, termed as structuralist’s critics, comes from structural economists which traces their origin to early classical works and popularized in development economics by the works of authors like Kaldor, Lewis, Nurkse, Rosenstein-Rodan, Kalecki, Taylor, Fitzgerald, the ECLA economists like Prebisch, Sunkel and Singer, among others.

III Macro Modelling in the African Context – an Overview\(^3\)

This section examines some of the main features of African macro models that might usefully be included in a prototype macro model for Africa. Although the relevant African macroeconomic framework that need to be adopted in macro modelling should broadly be similar to those outlined in Tarp (1993), there are a number of other specific features, not properly dealt with in Tarp (1993), which an African macroeconomic framework might usefully include. The first such feature is an ‘import compression argument’, as discussed in Ndulu (1986, 1991) and Rattso (1992b). Two other features, which we argue should also be incorporated into macro models of Africa are the ‘fiscal response to external finance’ and the ‘Dutch disease’ phenomena. An attempt to integrate these features into a prototype African macro is done in Alemayehu (2002). Leaving such development aside, this section will be devoted to the review of most published models of Africa with the aim of drawing lesson for the use in the EPPD/MOFED model.


\(^3\) This section is largely based on Alemayehu (2002) where the issue is discussed at greater detail.
3.1 An Overview of Some Published Macro Models of Africa

Although it is a bit outdated, a comprehensive survey by Harris shows that macro modelling in Africa is still in its infancy (Harris, 1985). Harris surveyed most macro models of Africa, which have been constructed by North American Universities and international institutions as well as published models of the African economy. He reports on a total of 184 macro models, 120 of which he evaluates (See Diagram 3.1). Harris classifies the 184 models based on their underlying structure. Thus, models are categorised as 1) demand driven Keynesian type models; 2) supply driven, general equilibrium with price adjusting to clear the market; 3) reduced form monetary driven; and, 4) models based on consistency checking, without formal closure (See Diagram 3.2). Harris also applies a classification based on publication and sponsorship. Thus, models are grouped as: 1) PhD Dissertations; 2) University-based professional work; 3) International agency sponsored; and, 4) models developed by African governmental agencies (Diagram 3.3). Harris’ data is summarized below.

![Diagram 3.1: Number of African Macro Models (Harris, 1985)](image1)

![Diagram 3.2: Type or Structure of African Macro Models (Harris 1985)](image2)
These models emphasize different aspects of African economies. Thus, in order to understand how these models work, a number of different types of African macroeconomic models are examined below. While some of these models study the impact of foreign borrowing or, indeed, a sudden onset of oil (or other mineral) revenue on the economy, others focus more on fiscal conditions. However, in the following discussion, the concern will not primarily be with the objectives of each model though the objectives may shape the type of modelling undertaken. Rather, the focus is on how these various approaches have been applied in building models of African economies. From this, some lessons which may help in developing a prototype macroeconomic model for Africa in general and Ethiopian in particular can be drawn.

3.2. Theoretical Considerations

The knowledge about the operation of the economy is one of the key aspects in designing policy or evaluating alternative policies. In the macroeconomics literature, there are different ways of viewing how the macro economy operates. Hence, it is natural that modelling strategy depends on the assumption made about the working of the economy. Following Harris (1985), we can classify the types of macro models into Keynesian/demand driven, supply driven, general equilibrium class of models, and reduced form monetary model. Apart from this classification, we may also have a VAR approach to macro modelling pioneered by Sims (1980) in which the objective is to fit the data with less regard to apriori theoretical consideration (called structural models). The theoretical underpinning of VAR models and their variants, such as cointegrating VAR approach, will not be discussed in this section and the detailed discussion can be found in Sims (1980) and Garratt et al. (1999). However, some empirical models constructed in this framework are discussed in section 3.3.

Demand Driven Models

Demand driven models are essentially based on the Keynesian framework in which supply does not play any significant role. In this class of models, supply passively adapts itself to demand and that prices are frequently taken as given or changed parametrically (Backhouse, 1995). Thus, the main issue is finding the equilibrium values of interest rate and of output demanded by the economic
agents, given the price level (Branson, 1989). The ISLM models (and their extension to aggregate demand and supply, the AD-AS models) are classic examples of demand driven models.

The ISLM model offers a standard theoretical underpinning of monetary and fiscal policy in the context of demand driven models. The model variants normally considered include a closed or open economy, perfect or imperfect capital mobility, and fixed or flexible exchange rate regimes. Usually a combination of scenarios is assumed and policy analysis is accordingly pursued (Murinde, 1993).

In practical modelling exercise, aggregate demand is disaggregated into its components – i.e. consumption function, investment function (both depends on the level of income), and exogenously given government expenditure. The external sector and the money market are then specified. Input-output models could also be linked to such formulation so as to determine the level of sectoral output requirement which renders final demand disaggregated by commodities. In this class of models, the closure rule equates output to aggregate demand. Since supply and prices do not play any role in the model, policies can have impact on real variable through their effect on aggregate demand.

**Supply Driven Models**

In the supply driven models, productive capacity is the main determinant of output. “The key analytical equations are production functions that relate outputs to factor availability and technology, and factor accumulation rules such as saving determined investment level” (Harris, 1985:20). The Harrold-Domar and Solow type neoclassical growth models; and consistency check based models such as gap models and RMSM are some of the supply driven models.

The closure rule varies cross models considered. For instance, in the classical growth models Says’ Law is assumed to hold. In the neoclassical models of small open economies, assuming perfectly elastic supplies of import and demands for exports, output composition problems can always be overcome through trade (Harris, 1985). In the context of gap models, the closure rule depends on the assumption made about which gap prevails.

**Reduced Form Monetary Models**

These are models that are based on the pioneer work of Polak (1957). They are popularized, with some extension, as ‘the monetary approach to the balance of payment’ by Whitman (1975) and Frenkel and Johnson (1976), as well as by the IMF’s research department which named them as ‘the financial programming models’. Its fundamental basis is that the balance of payments is essentially a monetary phenomenon. As Pilbeam (1998:105) put it “Not only is the balance of payments a measure of monetary flows, but such flows can only be explained by a disequilibrium in the stock, demand for and supply of money”.

The IMF financial programming model is designed to determine the magnitude of domestic credit expansion, as shown above, required to achieve a desired balance of payments target under a predetermined exchange rate (Agènor and Montiel, 1996). In the words of Frenkel (1991: v) “[financial programming models] start from the proposition that in an open economy with a fixed exchange rate, the money supply is an endogenous variable reacting to surpluses and deficits in
balance of payments and not an exogenous policy instrument, as is customarily assumed in a closed economy. These models derive a formal relationship between changes in the domestic component of the money stock and changes in international reserve, which can then be employed for setting policy. Specifically, the models allow one to obtain a value for the policy variable – domestic credit - that is consistent with a desired balance of payments position’ (see section II above).

The closure rule for such models can either be classical or Keynesian. In the classical case it can be solved for the domestic price level, taking real output as exogenous. In the Keynesian case it can be solved for the changes in real output taking the price level as given (Agènor and Montiel, 1996).

**General Equilibrium Class of Models**

(a) **Computable General Equilibrium Models (CGE)**

CGE models are used to analyse the complex linkages among economic agents that characterize a general equilibrium system (Robinson and Roland-Holst, 1988). CGE models are mostly constructed based on Social Accounting Matrices (SAM). The model works by simulating various economic actors across markets (Robinson, 1989). As the name indicates, the model incorporates a complete specification of both the demand and supply sides of all markets. CGE models can be classified into neoclassical and structural.

In the neoclassical CGE models, optimising behaviour of agents is assumed and incorporated in equations describing their behaviour, which essentially describe various first order conditions for profit and utility maximization (Robinson, 1989). In addition, the assumption of full employment is also maintained. As any other neoclassical models, product and factor prices are flexible and serve as major equilibrating variables.

Structuralist CGE models form another strand of the literature. According to Taylor (1990:1) “[s]tructuralist thought considers that structural characteristics of the economy are fundamental to its behaviour. Among the structural factors are distribution of income and wealth, tenancy relationships on the land, the type and degree of specialization in foreign trade, the density of chains of production, the degree of concentration in markets, control of the means of production by distinct types of actors, functioning of financial intermediaries, and penetration of technical advance, as well as socio-political factors associated with the extent of organization of the working class and other influential sectors and classes, the geographical and sectoral distribution of the population, and its level of skills”. Thus, in the structuralist tradition, disequilibria are explained as being caused by political and social conflicts. The structuralist CGE model is, therefore, constructed to reflect such peculiar feature of the economy. This is in sharp contrast to the neoclassical CGE models that is essentially based on optimization.

(b) **Econometric General Equilibrium Models**

The econometric general equilibrium models are based on the specification of aggregate demand and supply along with the money market and exchange rate determination equations. The standard neoclassical general equilibrium models, such as the RMSM-XX, fall under such category. The neoclassical general equilibrium model specification contains the money market, goods market and the labour market, all being the function of set of prices such as real wage and interest rate.
Equilibrium condition in each of the markets is also specified to maintain the general equilibrium condition.

General equilibrium models can differ depending on the specific closure rule employed. For instance, using the neoclassical general equilibrium model without instantaneous market clearing, we may have some form of disequilibrium model in which equilibrium is restored through movement of both prices and other variable. Prices can serve as equilibrating variable in a case where excess demand prevails while the adjustment may come through capacity under utilization if excess supply prevails. In the context of general equilibrium model, inconsistencies may also be absorbed through passive accumulation or de-accumulation of stocks, fiscal deficits or balance of payment deficit or surplus (Harris, 1985). These types of models have a desirable characteristic that both the supply and demand sides of the economy are emphasized and modelled explicitly. This helps to limit relying on extreme positions such as supply creates its own demand in the case of supply driven models or supply adjusts to demand in demand-driven models.

3.3. The Empirical Literature: With a Focus on Africa

In this section, attempt is made to show the specific features of some of the models that fall under the category of demand-driven, supply-driven, general equilibrium as well as VAR based models. The classification is mainly based on the main closure rules assumed in the models.

Demand-Driven Models

Many demand driven macroeconometric models are built to depict some of the African countries. For instance, Oshikoya (1990), Egawaikhide (1997) built macroeconometric model for Nigeria and El-Sheikh (1992) for Egypt. Though their focus and the problem they attempted to address differ, their basic framework is similar.

Oshikoya’s (1990) model is composed of 7 major blocks (domestic expenditure block, public finance and money supply block, foreign trade and balance of payment block, input-output production sector, national income block, factor of production block, and wage and prices block) with 25 stochastic equations, 5 input output relationships and 38 identities and definitions. The macro model of the final demand is complemented by the inter industry supply flows through the input-output model. The residuals in the sectoral value added from the input-output model are also modelled as stochastic equations with the inclusion of capital stock, inter alia, as a proxy for supply constraints in production. The major innovation of the model is that it incorporates the input-output model into the macroeconometric model to capture the inter-sectoral linkage.

El-Sheikh’s (1992) model is a demand driven macro-sectoral model of Egypt which attempts to capture the interaction between financial sector, balance of payment, production sector and prices. The model constitutes 31 behavioural equations and 9 identities with four major blocks: the demand components block, production sector block, public finance and financial sector blocks. The model is fairly detailed and attempts to capture the institutional regularities of the Egyptian economy. The attempts to relate the input-output formulation with the macroeconometric structure (à la the
Keynesians line) and the degree of disaggregation of the model are its positive sides. However, the use of exogeneity assumptions regarding investment (both private and public) and the government expenditure in the model seem rather unrealistic.

Egawaikhide’s (1997) demand driven model of Nigeria is somehow different from the above models with its emphasis on the demand side. The model is built in an open economy ISLM framework (except that prices are endogenously determined). The model has the objective of analyzing the effect of budget deficit on the current account. Consistent with the ISLM framework, the model implicitly assumes a passive aggregate supply that adjusts to the change in the level of the aggregate demand. In general the model is fairly good for its objective though it is small. The OLS-based estimation procedure, however, suffers from simultaneity bias that does not address the contemporaneous correlation between the endogenous variable and the disturbance term in the system. Moreover, the results may also be spurious as there is no test for the time series properties of the variables.

Similarly, there were a number applied demand-driven macro models in Kenya, the most influential ones being ‘The Macroeconomic Policy Model for Kenya – or the Chakrabarti Model’ and ‘The Medium to Long-term Macro Model for Kenya - MELT3’. These models are built in the Keynesians spirit and hence are demand driven. However, these models are poorly estimated, outdated in the new era of liberalization, and lack coherent theory. These problems are addressed in the new aggregate demand and supply based model of the Kenyan Institute for Public Policy & Analysis (KIPPPRA)-Treasury Macro Model (KTMM). (See Karingi and Ndung’u (2000) for a review of Kenyan Models; and Huizinga et al 2001 and Alemayehu et al 2001 for the new model).

Supply Driven Models

With the dissatisfaction of the demand-driven models in the 1970s and with the recognition of the supply-constrained nature of developing economies, many supply-driven models mushroomed since the 1980s. Asemerom and Kocklaeuner (1985) and Lemma’s (1993) model for Ethiopia; Lipumba et al’s (1988) model for Tanzania; Van Frausum and Sahn (1993) for Malawi; and Perera (1994) for Sri Lanka are cases in point.

Though these models are constructed to analyze different issues (for instance, Perera’s objective is to assess the impact of exogenous shocks and macroeconomic policies while Van Frausum and Sahn’s (1993) interest is to measure the effects of external shocks), their theoretical basis is not different. In all these models, disaggregation of the production side is emphasized. The demand side is specified by recognizing the supply constrained nature of the economy in question. For instance, Lipumba et al. (1988) specified their investment function by a supply constrained accelerator model. Similarly, Perera (1994) specified the demand side of the model under each production sector emphasizing the importance of the supply side.

This class of models also model the dynamics of the balance of payment by linking it with the production structure. Van Frausum and Sahn (1993), among others, modelled export as a function of the level of cash crop production and relative prices; imports as a foreign exchange constrained function where foreign exchange availability (i.e. value of total exports plus long term borrowing net of factor payments) and credit worthiness indicators are the arguments. With this structure, the model shows how the current account balance could ultimately be transformed into external debt. The external debt (identity) is modelled as a sum of one-year lagged debt stock and the balance of the current account.
General Equilibrium Models

(a). Computable General Equilibrium (CGE) Models

In the 1990s, many CGE models are constructed in the context of developing countries. Among others, Davies et al. (1994), Decaluwé et al. (1994), Go (1994) and Storm (1994) constructed CGE models for Zimbabwe, Rwanda, Philippines and India, respectively. (see Robinson 1988 for a survey of CGE models). As general equilibrium models, the common feature of these models is their closure rule that equates the demand and supply conditions in a flexi-price market set-up.

Davies et al. (1994) tried to model the impact of state regulation and interventions and hence the resultant import compression in Zimbabwe. The regulations are analysed within a macroeconomic framework that is build around a social accounting matrix (SAM) for 1985. The model comprises three sectors: food agriculture, non-tradable and tradable. In the specification of the tradable sector the policy rule for the allocation of foreign exchange and its impact on import and capacity utilization is clearly articulated. The model is used to address some important questions such as 'what are the driving forces behind growth?', 'what is the impact of exchange rate policy? 'what are the consequences of drought and change in public expenditure patterns?'. Nevertheless, some of the stringent assumptions of the model, such as the exogeneity assumption about the agricultural sector and investment, may limit its use.

The model of Decaluwé et al (1994) has the objective of analyzing the impact of different policies under conditions of credit rationing. From the supply side, the model divided production activities into three sectors: export crop production, manufacturing and other production activities. In the demand side final demand is equated with total investment expenditure and consumption. Finally, the income of firms and commercial banks is derived from the SAM. The model depicts the financial constraints and models their impact on the supply side. With this formulation, the model helps to show a typical financially repressed economy.

The models of Go (1994) and Storm (1994), unlike the above ones, are rather constructed in a dynamic context. Having the objective of analysing the effect of external shocks and adjustment policies on investment and growth. Go’s (1994) model incorporates inter-temporal choice and forward-looking behaviour in investment and consumption decisions. At each point in time, consumption is set as an increasing function of wealth. Investment is also an increasing function of Tobin's q. Saving and investment decisions are assumed to be separate and simultaneous. The equality of savings and investment is assumed to be brought by an adjustment in the level of foreign borrowing supplied at a given world interest rate.

The dynamic CGE model of Storm (1994) is built for a mixed economy, India, to assess the macroeconomic impact of agricultural policies. Agricultural prices are assumed to fluctuate to clear the market. In the case of rice and wheat the price adjustment is subjected to lower bound procurement prices. On the other hand, the non-agricultural sectors display a mark-up pricing scheme due to its oligopolistic structure and capacity under-utilization. The sector's output is determined by sector wise demand, presupposing under-utilization of production capacities. Generally, the attempt to capture the institutional arrangements and their impact on the economy is an interesting aspect of this model.
(b) Econometric General Equilibrium Models

The prototype model of Haque et al (1991) is a general equilibrium macro economic model built in the context of developing countries. The model is constructed in a flexible price Mundell-Fleming framework and it includes both the demand and supply sides. From the aggregate demand side consumption is specified as a function of real interest rate and disposable income. The investment function is basically an accelerator model where real interest rate differential is included as an additional argument. Trade balance is captured through the specification of export and the import functions. Exports are assumed to be a function of the real exchange rate and foreign income while imports are related to real domestic output and the real exchange rate. Finally, the government sector is assumed to be exogenous.

On the supply side, the economy's aggregate supply function is specified as a Cobb-Douglas production function with the assumption of complete wage-price flexibility. In the money market, the money supply and domestic interest equations are specified. The money supply equation is given as a sum of domestic credit and foreign exchange reserve where the latter is determined endogenously through the balance of payment. The domestic nominal interest rate is specified to depend on foreign interest rate, expected change in exchange rate and degree of capital mobility.

The prototype model explained above is estimated for 31 developing countries. The inclusion of the assumption about the degree of capital mobility into the model and endogenizing the foreign exchange reserve accumulation are the positive sides of the model. However, some of the basic assumptions of the model seem unrealistic for developing countries. For instance, the assumption of complete wage-price flexibility and some degree of monopoly power assumed to be exercised by the developing countries in the world market do not seem realistic. The authors’ claim that they have used an efficient estimation technique that controls for country heterogeneity, using fixed effects model (such as Brazil, Chile, S.Africa, Ethiopia, Kenya, etc). However, they do not seem to get reasonable estimates. Moreover, their result may not be robust in the face of the recent estimation techniques that consider unit root and cointegration in panel data.4

Bodart and Le Dem (1996) have also constructed a macroeconometric model in a general equilibrium framework for Cote d’Ivoire with the objective of analysing the labour market. The model is constructed on the assumption of small, open developing country with a pegged exchange rate regime and perfect capital mobility. The economy is divided into three production sectors: agricultural and urban formal & informal sectors which basically produce non-tradable goods and services. The demand side is represented by the usual Keynesian way comprising private & public consumption, investment, and trade balance. The allocation of the labour force is disaggregated and related to each of the production sectors and the public sector.

The disaggregation of the model, especially the labour market, the attempt to derive the labour demand of each production sector from the first principle and to explicitly introducing the informal urban sectors are its strength. However, the model is based on limiting assumptions such as perfect capital mobility and non-existence of rural unemployment. These assumptions have serious implication in the model. For instance the assumption of perfect capital mobility is manifested in the closure of the model where external financing gaps are closed automatically. The assumption of the

4 See Pesaran, 2000 and Lm, et al. 1997 for a detailed discussion of this method.
non-existence of rural unemployment is also manifested in the wage determination of the agricultural sector, which is based on the agricultural average productivity.

**Vector Auto Regressive (VAR) Based Models**

Chishti *et al.* (1992) have constructed a macroeconometric model of Pakistan using a VAR approach. The VAR model contains ten 'key' macroeconomic variables that are related to the stabilization policies. The model is estimated based on unrestricted VAR and employs an F-test and impulse response function to analyze the anticipated and unanticipated shocks. The F-test shows that real GDP, price and the external resource are affected by anticipated policy shocks while the other variables are invariant with such shock. The impulse response exercise also shows the effect of conventional stabilization policies such as monetary and fiscal policy shocks. However, the approach (also referred as ‘Sims unrestricted VAR approach) has been subjected to a number of criticisms. As discussed in Garrat *et al.* (1999) first, the approach requires care in the initial stage of transformation of the data to achieve stationarity. For example, a VAR model of the first-differences of I(1) variables is misspecified if there exists a cointegration relationship between two or more of the I(1) variables. Second, the variables included in such a VAR model are arbitrary and it is difficult to imagine how this choice could be made without reference to some underlying economic theory.\(^5\) The model could have been appealing from both theoretical and empirical aspects if it were constructed in a structural (cointegrating) VAR framework.

Kouassi (1997) also constructed a structural cointegrating VAR based macro model for Cote d’Ivory. He classified the economy into three blocks: public finance, balance of payment and the money market blocks to analyse the impact of external shock on the domestic economy. Unlike the model of Chishti *et al.* (1992), the VAR is specified by imposing some structural relationship - hence it is a structural VAR. The model is estimated using unrestricted VAR approach after identifying the cointegrating relationships. The model is then used, *inter alia*, to show the effect of external shocks (mainly terms of trade shock) on government budget.

Based on the above review, one might reasonably conclude that most of the published macro models in Africa have the aim of studying the impact of external factors on the economy. Although a rigid classification would be difficult, since overlapping objectives are common, nevertheless the reviewed African models may broadly be grouped into those which: 1) focus on the impact of foreign capital and foreign exchange earnings on major macro variables (Lipumba *et al.* 1988, Oshikoya 1989, Davies *et al.* 1994); 2) stress the impact of oil revenue (Olofin and Iyanwura 1983, Benjamin *et al.* 1989, Benjamin 1990); 3) focus on the impact of external shocks in general (Lipumba *et al.* 1988, van Frausum and Sahn 1993, Kayizzi-Mugerwa 1990); and, 4) focus on domestic macro economic conditions and policy (Boutros-Ghali and Taylor 1980, Asmerom and Kocklaeuner 1985, Pleskovi 1989, Harton and McLaren 1989, Lemma 1993, Berhanu 1994 (see below), Decaluwé and Nsengiyumva 1994, Davies *et al.* 1994).

The lessons from these efforts to depict the workings of an African economy is many fold. Firstly, African macro models should focus more on the supply-constrained nature of the economy. This may be done by concentrating more on the role of both intermediate imports (in the short to medium term) and on capital formation (as representing a longer run concern), as well as on their mechanism of financing. Second, sectoral adjustment (between traded and non-traded sectors) could represent an important focus

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\(^5\) See Pagan (1987) for discussion about the pitfall of using such method.
for future efforts. And, finally, the government fiscal posture and the monetary sector need to be linked, and should be left open to the influence of external sector. In addition to these general lessons, a number of technical recommendations (for example on combining input-output analysis with econometrics), the use of the structural VAR approach, may be drawn from these models. These recommendations, taken alongside a number of theoretical issues could form the basis for the construction of a prototype model for Africa (see Alemayehu 2002).

IV. Theoretical and Applied Macro Modelling in Ethiopia

4.1 Academic (University) based Work

Berhanu (1994) has built a Kalecki-FitzGerald inspired macroeconomic model of Ethiopia. The model is very small, having only six equations. In the first of these equations, the manufactured price is formulated, \textit{a la} Kalecki, while, in the second equation, marketed surplus is formulated as a function of internal terms of trade. In the third equation, the total output of the manufacturing sector is assumed to equal the marketed surplus, non-food consumption of wage earners in the manufacturing and export sectors and the unsaved profit of capitalists. The remaining equations define total profits in the economy, the demand and supply of basic goods (including imported ones), the external balance, and, finally, investment (which is constrained by balance of payments).

The model assumes, \textit{inter alia}, that the agricultural output market is not flexi-price, and that investment (not output) adjusts to the foreign exchange constraint. These assumptions neither follow the standard structuralist assumptions, upon which the author claims his model is based, nor tally with the stylized facts in Ethiopia. Rather, peasants in that country had been marketing a good portion of their output in the flexi-price market, most industries were extremely import-dependent, and import compression (with its adverse effect on capacity utilization and output) was the rule during the period (1974-1990) for which the model is constructed. Moreover, the (‘socialist’) state, as centre of accumulation, is not well integrated into the model. The model also contains a number of other limiting assumptions. Manufactured goods are assumed to be necessities within rural household consumption, the model abstracts from the debt problem and hence balance of payments is essentially assumed to be a trade balance. These assumptions seriously limit the relevance of the model. Thus, if we assume that import compression takes place, then some of the arguments and conclusions set out in this model may no longer be sustained.

Notwithstanding such shortcomings, the model gives an interesting analysis of the distribution of income, process of accumulation/growth and the policy dilemma facing different agents. Its importance should also be seen in the context of a virtual absence of macro models for Ethiopia\(^6\). This analysis would have been more illuminating if mark-up pricing and its effect on accumulation had not been assumed to have foreign exchange constraint. Indeed, it could be argued that this foreign exchange constraint, rather than the author’s emphasis on the share of profit, should have been the focus of analysis, in relation to accumulation (see Alemayehu, 1997).

Lemma (1993) constructed a macroeconometric model for Ethiopia. The model has 53 equations (of which 14 are behavioural and the rest identities) with four major blocks: production sector and investment, foreign trade, public finance and price blocks. The model is essentially supply driven and

\(^6\) Two exceptions to this include a fairly disaggregated but extremely simplistic Keynesian model, developed by Asmerom and Kocklaeuner (1985); as well as quite a promising supply driven model developed by Lemma (1993) (see below).
has two productive sectors- agriculture and non-agriculture. The agricultural sector is related to the real relative price the farmers receive, the supply of manufactured goods to the farming sector and other exogenous variables like rainfall. The value added in the non-agricultural sector is specified as a function of the level of monetary investment. The aggregate level of investment, in turn, is a function of major source of funding such as government savings, credit from banking system and foreign capital inflow.

The foreign trade block contains three export supply functions (private export functions for pulses and hide; and public coffee export function) and two import demand functions (capital goods and raw material imports); and consumers goods import is assumed exogenous. The government sector consists of two behavioural government revenue functions (direct and indirect taxes revenue functions and import tax function) and an identity for export tax revenue function. The government current expenditure and export tax rates are treated as policy instruments. Finally, the price block identifies two price equations based on consumer price index (CPI) and industrial sector price deflator. The change in CPI is related to excess domestic demand (a pure monetarist formulation) and rate of inflation for imported goods. Price in the industrial sector follows a mark-up rule and is indexed to the CPI in the structuralist tradition.

The model, by and large, describes the structural and institutional peculiarities of the Ethiopian economy and its policy-making institutions of the socialist era (1974/75-1991). However, a significant part of the data (10 observations out of 18) refers to the pre-1974/75 period which may not be described by the model due to institutional and structural differences between the two periods. In addition, some of the model’s assumptions, such as the exogeniety of government current expenditure and agricultural price, are questionable. In the case where the economy is open for external shocks such as war, drought and terms of trade fluctuations, the exogeniety assumption on government recurrent expenditure will be unrealistic. To the extent that peasants in Ethiopia had been marketing a considerable part of their produce (after fulfilling the levied quota by Agricultural Marketing Corporation) in the flexible price market, treating agricultural price as purely exogenous is not realistic either. The exclusion of the monetary sector and the formulation of CPI equation may also need improvement. Above all, the empirical version of the model suffers from simultaneity bias and problems of spurious regression as each equation in the model is estimated by OLS.

Asemerom and Kocklaeuner (1985) also constructed a supply side macroeconometric model, which is set in the Keynesian framework, for Ethiopia. The supply side of the model disaggregates GDP by the production sectors: agriculture, other commodities, construction, distributive and other services. From the expenditure side, the consumption function (for both private and public), sectoral investment functions, export and import functions are specified. The export function is disaggregated into coffee and non-coffee and imports are also disaggregated into capital goods, intermediate goods, consumption goods, fuel, and service imports. Savings are disaggregated into private and public and specified separately. Finally, the saving and the trade gap equations, assuming the trade gap is binding, closes the model.

The model is fairly disaggregated. But, as Lemma (1993) noted, the sectoral equations are not interconnected to capture the simultaneity in the system and hence an exogenous shock in one variable would fail to have any impact on the rest of the system. Moreover, because of the absence of price equation, the effect of disequilibrium between aggregate demand and supply would completely spills-over to the foreign balance and hence it over or under estimates the foreign exchange gap.
4.2 Applied Macro Models in Ethiopia

Ethiopia has never used comprehensive models for policy analysis, planning and budget preparation. However, there were two models that were developed by the Ministry of Finance and Economic Development. In this section we will briefly review these models and attempt to draw lessons from these exercises with the view of helping us to developing an applied macro model for Ethiopia.

The RMSM-X Model

To forecast the impact of different policies, the modelling unit of the then Ministry of Economic Development and Cooperation (MEDaC), now MOFED, built the RMSM-X model which in essence is not different from the RMSM model (discussed in section II) except the inclusion of some behavioural relationships. The model is constructed with a closure that would forecast the necessary fiscal, monetary and credit policy variables in order to achieve certain target rate of growth, inflation and foreign reserve.

Being a RMSM model, it contains the required accounting relationships and some behavioural equations with the aim of capturing some structural relationships. The model also incorporated a flow of funds framework to maintain an overall consistency in resource balance. This stands as an interesting aspect of the model.

MEDaC's RMSM-X model suffers from poor specification of the structural equations. The equations are neither justified theoretically nor supported empirically in the Ethiopian context. The closure that posits that saving is equals to investment in the neoclassical fashion is also another contentious point, which needs empirical justification. The adjustment mechanisms in the model are not also well articulated. For instance, the model does not show how, if there is any, disequilibrium in the money market adjusts.

In general, though the model is limited on the above ground, it is an important tool for policy analysis given the lack of alternative models. The model might have a better forecasting ability if the forecasting horizon is limited to the short-term rather than the medium-term that it attempts to cover.

The National Income Forecasting Model

The other applied macro model which is built by MEDaC is ‘The National Income Forecasting Model’. As the name shows, the basic purpose of this model is to formulate an econometric model framework that is capable of forecasting the national income variables. Using the production side, the model disaggregates the production sectors in to agriculture, industry, services and other distributional services. Within these broad categories, the model further disaggregated each sector into their constituent part and behavioural equations are specified and estimated for each sector.

Though the disaggregation of the model, in particular in the agricultural sector, is quite interesting, the specifications of the behavioural equations are not either based on any theoretical framework or earlier empirical evidence. For instance, some empirical evidences suggest that capital (in the form of oxen) and availability of credit are very important in explaining the Ethiopian agricultural. Omitting these important variables, as is done in the model’s specification of the agricultural sector, would lead not only to a serious bias in the forecast values but also limits its policy relevance. In addition, the
model also suffers from poor econometric techniques. The model ignores the problems of simultaneity bias as well as the possibility of spurious regression problem and does not address the time series properties of the variables. With a very small degrees of freedom (ranging from 1 to 9 degrees of freedom) the parameters of the model are not of any practical importance.

Be the above limitations as they may, this model is a step forward in terms of building systematic framework to forecast national income variables. It in particular helps to maintain the consistency of the overall national accounting framework. Addressing the poor econometric techniques and improving the theoretical specifications would make the model an important forecasting tool.

V. By Way of Conclusion: The Need for Applied Macro Model for Ethiopia

As noted above, there have been attempts to construct macro econometric models by the then Ministry of Economic Development and Cooperation (MEDAC) the now MOFED. The models were initiated with specific purpose. However, none of them were put to use for the purposes for which they were intended. The reasons for this, according to MOFED experts, among others, were:

a. The modelling exercises were not institutionalized: It would have been worthwhile attaching such an exercise either to the Economic Policy Analysis Team or the National Accounts Team of the Plan Preparation and Macro Policy Analysis Department of the former MEDaC so that the models could be routinely used and subsequently institutionalised;

b. The exercises and subsequent tasks were not adequately planned: Although there were valid reasons for undertaking the exercises, the modelling should have been phased at different levels and prioritised with regard to data availability, in house technical capacity and involving other stakeholder institutions. This would have allowed for sustained and smooth flow of data, and would have created a sense of national ownership;

c. Thee was lack of working relationships with academic and research institutions: This might have helped enhance in-house technical capacity of the lead institution (the then MEDaC and now MOFED), and thereby create a basis for demand driven modelling exercises. This would have facilitated sustained use of (and constant improvement of) the models for policy analysis and simulation purposes.

It is time, thus, to overcome the shortcomings and build an applied macro model for Ethiopia. The justification for having such a macro model at MOFED should be obvious. This is particularly so since MOFED is responsible for planning, budgeting and policy analysis tasks of the government.

One justification for having a macro econometric model is its capability for policy simulations. This is crucial for policy makers, as it aids them in assessing implications of proposed policies before implementation. Policy analysis conducted with the aid of such models avoids the risk of partial understanding of issues of national significance by considering inter-linkages in the economy.

Note form EPPD/MOFED proposal for Long-term study and macro modelling project.
Macro models also encourage researchers to investigate a wide range of issues, including external shocks (e.g., price decline for exportables such as coffee), domestic supply response, and implications of alternative policies, thus creating a better understanding of the dynamics of the Ethiopian economy. The feedbacks will in turn help improve the model and hence policy analysis and formulation.

Making concrete the objectives set out in the various policy and strategy documents, for example the SDPRP, requires translating policies and strategies into a budgetary framework. The evolving approach in most developing countries is the use of the Medium Term Expenditure Framework (MTEF). This is one vehicle for efficient and effective utilization of resources, aimed at promoting pro-poor growth and poverty reduction. The MTEF requires an overall macroeconomic framework that ensures consistency in defining the aggregate resources, and how resources are allocated among sectors. It also requires projections of major macroeconomic aggregates for at least three years, using disaggregated fiscal variables. As the preparation of annual budget and forecasting of key macro aggregates needs consistency, sectoral composition (indicating priorities in resource allocation) will not be effected in a discretionary manner. This can best be achieved using a macro econometric model with an elaborate fiscal block.

At the moment, the Macroeconomic and Fiscal Framework (MEFF) serves as a starting point for preparing annual budgets for public bodies, on the basis of the three-year indicative planning figures (IPFs). The IPFs are prerequisites for the preparation of the Public Investment Programs (PIPs). The PIPs form the basis for the preparation of the capital budget as required by the Council of Ministers’ Regulation No. 17/1997.

The MEFF is only one aspect of the MTEF, which calls for more detailed analysis. Presently, the MEFF preparation process is time-consuming, as it involves the collaborative efforts of various departments in MOFED and other nation-wide institutions outside of MOFED (e.g., the National Bank of Ethiopia). This rather cumbersome process must start afresh each fiscal year. A short-term macro econometric model could easily handle this process with much less effort than being currently expended.
Reference:


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