CHAPTER 4

MACROECONOMETRIC MODELLING IN PRACTICE: A SURVEY OF EMPIRICAL LITERATURE

4.1 INTRODUCTION

The preceding chapter attempted to review the theoretical underpinnings on macroeconometric modelling. This chapter presents some recent developments in macroeconomic modelling that are used to model either developing or transitional economies in particular. While it is important for the interrelationships explored in a macroeconometric model to have a strong theoretical base, it is well known that the role of theory is to provide a guideline regarding the direction in which the variables may affect one another. The need to understand the nature of the interrelationships for individual specific country cases has spurred voluminous empirical works on macroeconomic modelling. This chapter takes over from the previous chapter to explore the empirical side of macroeconometric modelling. These empirical works have a common objective of unveiling the nature of these interrelationships so that policy makers can engage in policy decisions with some reasonable degree of precision. The review presented in this chapter is divided into two sections. The first section makes a critical review of existing macroeconomic models of Lesotho. The second section reviews empirical macroeconomic models applied to other countries and other relevant and related literature.

Model building has proven not only to be a matter of applying appropriate techniques, but more importantly, a question of integrating any specificity of the studied economy. As Haque *et al*. (2000) points out, lack of consensus on analytical macroeconomic models, for developing countries in particular, is more pronounced at the empirical level. Often, the structure of a model will exhibit the view of the institution using it on the economy. Many studies have been conducted to construct and estimate macroeconometric models for different purposes. In the case of developing economies,

the nature of data problems that are encountered, require specific techniques be applied in the process of macroeconomic model building. More precisely, more *a priori* information has to be introduced in models. This implies that the specification of equations should follow simple economic theory, and coefficients calibrated accordingly if the need arises. In addition, some specific econometric methods may have to be used. More precisely, filtering techniques may have to be used either to estimate missing data or to estimate coefficients that are likely to vary along the sample range in cases of structural change.

4.2 A CRITICAL REVIEW OF LESOTHO MACROECONOMIC MODELS

Macroeconometric modelling in Lesotho does not have a long-standing history. There are six macroeconomic models of Lesotho, known, at least to the author. Three models are of the CBL, two of these have been modified to serve commercial purposes and the last model was developed as an academic exercise. Almost all known macroeconometric models of Lesotho have had a policy focus with varying emphasis on specific areas and sectors. Needless to say, the two models of the CBL place more emphasis on the monetary sector and monetary policy. The third model of the CBL is currently in the construction phase. The fourth model, developed by Akano (1998), is largely an academic exercise and is highly aggregated, highly simplified and place much emphasis on the demand side of the economy. The last two models are modifications of two of the CBL models developed to assess the impact of the LHWP activities on the economy. Each of these models has however proved to be a one-time exercise as they have not been updated and are therefore currently obsolete.

In order for a model to be operational in the purposes for which it has been designed, macroeconometric modelling has to be a continuous activity that requires frequent updating. This exercise is crucial for the policy analysis and forecasting performance of a model as it entails the changing of the model with other factors that may affect its validity. In particular, the following aspects are important:

- The incorporation of new information or data;

- The incorporation of developments in economic theory and quantitative methodologies; and
- The incorporation of changes in the structure of the economy.

One of the major weaknesses of the existing and complete models is their *ad hoc* approach in modelling the supply side of the economy and hence failure to recognize the supply side as a driver of the economy. More specifically, the production function is not estimated explicitly to derive factor demands. Thus, neither of the models can project the employment level and hence the effect of policy on this variable. A review of some of these models, for which details were available, is presented in the following sub-sections.

4.2.1 The Polak Model of the Central Bank of Lesotho

The Central bank of Lesotho has two different macroeconomic models that characterise the economy of Lesotho. The Central Bank of Lesotho, in conjunction with the IMF, constructed the first model in the 1980s. This was in the form of a Polak model, after Polak (1957), and was developed as a core framework applied by the IMF in applying the stabilization programmes. The model has four endogenous variables and three exogenous variables, namely, the money stock, nominal income, imports of goods and services, net foreign assets, exports of goods and services, net capital inflows and net domestic credit respectively. Equations corresponding to the endogenous variables relate the money stock as a constant proportion of income and imports as a constant proportion of nominal income. The other two equations are definitional equations that describes the change in money stock as the sum of the change in net foreign assets and the change in net domestic credit and the change in net foreign assets as the sum of the exports and net capital flows less imports. These equations are used to derive the reduced form equations of the model, which give income and imports as functions of the exogenous variables, the velocity of circulation of money and the propensity to import out of income. While the model can be used for policy analysis, it has several limitations and weaknesses, including the fact that it disregards the real side of the economy.[57]

[57] See Karingi and Ndung'u (2000) for details of the limitations of the Polak model.

4.2.2 The Central Bank of Lesotho Macroeconomic Model (CBLMM)

Dogget developed the second model, known as Central Bank of Lesotho Macroeconomic Model (CBLMM) in 1996 in conjunction with the Central Bank of Lesotho. The CBLMM is used primarily to provide short-term macroeconomic forecasts and as a demand management instrument. The model is therefore constructed in such a way that supply is determined exogenously and responds only to accommodate demand. This construction derives from the prevailing institutional arrangements, which effectively render fiscal policy as the only feasible stabilisation tool.

The model divides the economy into five sectors, namely, the government sector, the monetary sector, the national accounts sector, the balance of payments sector and the LHWP sector. While the majority of variables in the national accounts and the balance of payments are endogenous and are assumed to be determined by conditions of aggregate demand in the economy, the variables in the other sectors are largely exogenous. Within the balance of payments block, the capital account is to a large extent exogenous. Government expenditures, domestic tax rates and government deficit financing are considered the major fiscal policy instruments and are therefore exogenously determined. Because of limitations in the scope of monetary policy as a result of institutional arrangements, the levels of net credit to government and the private sector are regarded as the monetary policy instruments and hence are also exogenously determined.

4.2.2.1 Basic assumptions of the CBLMM

The construction of the model follows three key considerations namely:

- Structural features of the economy and the institutional arrangements within the economy. These embrace the assumption of a small open economy, the fixed exchange rate between the Lesotho and SA currencies at a one to one basis and free capital mobility among the CMA members. By this design the model

recognises that the importance of these two arrangements is predominant in the limited scope of monetary and trade policies.

- To meet the demands of the uses of the model in assessing the implications of aggregate demand. In this regard the model is constructed with the implicit assumption that aggregated demand is unstable, being influenced to a large extent by the external economic environment and the domestic policy decisions. On the other hand, aggregate supply is perceived to be rigid, at least in the short run, because of the structural rigidities. Thus, aggregate supply is assumed to be exogenous and hence is not modelled explicitly.
- Economic theory. A simple Keynesian framework with the implicit assumption of a small open economy is assumed. In addition, a theoretical framework of the monetary approach to the balance of payments is used.

The model further assumes that macroeconomic policy in the economy aims at a stable macroeconomic environment. In the context of the model, a stable macroeconomic environment is defined in terms of two features, namely:

- That the rate of inflation in Lesotho does not deviate significantly from the rate of inflation prevailing in SA; and that
- The level of net foreign assets in the economy is either stable or increasing.

4.2.2.2 The national accounts sector

The model forecasts output from both the demand and the supply side. The supply side estimates real value added of five sub sectors, namely, the agricultural sector, the construction sector, the manufacturing sector, electricity and water services sector and the net indirect taxes, as functions of some components of real aggregate demand. Thus valued added is driven by aggregate demand in the model.

Output estimated from the demand side is represented in the models by four main expenditure categories, consumption, investment, exports and imports. The behaviour of investment is explained by the simple accelerator principle. In turn, imports of goods and

services are made to depend on consumption and investment expenditures as well as agricultural and manufacturing output. The closure of the national accounts sector is such that consumption is derived as a residual and hence a balancing item between output from the demand and supply sides.

Behavioural equations that explain price developments express price indices in various sectors as functions of price developments in the SA. These prices are in turn used to convert real value added into nominal terms.

4.2.2.3 The balance of payments in the CBLMM

All endogenous variables in the balance of payments are forecasted in nominal terms. The model views the capital account of the balance of payments as largely exogenous with variables such as foreign direct investment, loans and repayments, the financing of the LHWP and short-term capital flows as exogenous. On the other hand variables such as imports of goods, exports of goods, imports and exports of services, investment income and SACU non-duty receipts are considered endogenous.

Imports of goods are disaggregate into the exogenous LHWP imports and other imports of goods which are determined by aggregate demand conditions. Imports of goods are found to be influenced strongly by imports of goods and services that are determined in the national accounts sector. In turn, the aggregate exports of goods depend largely on aggregate demand conditions as well as relative prices and supply conditions in the manufacturing sector.

Labour income depends on the exogenous world dollar price of gold, economic activity in SA and drought conditions within Lesotho. Domestic income also influences labour income negatively. The SACU non-duty receipts are linked to customs receipts from SA as determined by the revenue sharing formula.

4.2.2.4 Estimation of the CBLMM

The behavioural equations of the model are estimated using the OLS method, with the sample period spanning from 1980 to the most recent information available and with DOS-based software. Although this model provides a reasonable approximation to the developments in the economy and was designed to be updated on a frequent basis, this has not been the case. The model has not been revamped adequately and constantly to keep up with the economy's structural changes, theoretical developments and recent estimations techniques. One of the major problems cited is the lack of capacity within the CBL to both update the model and to operate the software that it uses. Because of this, the model has become obsolete and is no longer in use.

4.2.3 The current macroeconomic model

The current macroeconomic model of Lesotho, still under construction, has several attractive features. It has seven sectors, namely, the demand side, the supply side, the monetary sector, the external sector, the public sector, the prices and wages sector and the employment sector.

The demand sector determines aggregate demand in the economy by stochastically determining private consumption, private investment and net exports. The supply side determines aggregate output in relation to the factors of production, capital and labour and the money market determines money demand and the rate of interest. In turn, the balance of payments consists of identities that describe the overall balance of payments, the current account balance, the capital and financial balance and a behavioural relation that explains labour income. The modelling of the government sector is rather parsimonious as it describes the government budget balance and the main revenue components modelled using trend-fitting and forecasting. The prices sector estimates the CPI, the export prices and real wages while employment is specified as a function of population and real wages. The equations of the model are estimated using the Engle-

Granger two-step procedure. At this point, the estimated equations have not been compiled into a system that represents a consistent framework.

4.3 OTHER RELATED LITERATURE

4.3.1 The production sector

The modelling of the production sector can take the form of the estimation of either the cost function or the production function. The former approach is less popular, especially in developing countries, owing to the inherent problem of data limitations. It, however, has the merit in that the estimation of the cost function and derivation of factor demands and price functions ascertain consistency with the profit-maximising and cost-minimising behaviour of the firms. This method is applied by Du Toit (1999) in a supply side model of the economy of South Africa. The study estimates a cost function, from which the production function is derived on the basis of Shephard's duality conditions.

The production sector in many macroeconomic models is made to determine output at either an aggregate or a sectoral level. A number of models examined in this study, for example, Musila (2002), Basdevant (2000), Haque *et al*. (1990), have determined output at an aggregate level. While a Cobb-Douglas production function is commonly used and found to be appropriate in most estimations, mainly because of its computational ease and simplifying assumptions, a CES structure has also enjoyed some degree of popularity in the context of macroeconomic models. In many models, output is often disaggregated into various value-added sectors depending on the availability of data. The challenge that this specification poses in many developing countries is lack of reliable time series on sectoral distribution of factor inputs. In this regard, Klein (1983) suggests the use of input-output (IO) approach to modelling the production sector to be adopted in such cases. By this formulation, the relationship between value added and components of final demand can be represented by the following expression.

$$VA_i = \sum_j h_{ij} F_j \qquad (4.1)$$

Where VA_j is value added in each sector i, F_j represents the final demand of user j and h_{ij} are the conversion parameters. One way of expressing this relation as a stochastic equation is to approximate $h_{ij}F_j$ by $a_{0j} + a_{ij}F_j + u_j$, where a_{ij} are coefficients and u_j is the error term. This process yields the following relation

$$VA_i = a_{0i} + \sum_j a_{ij}F_j + u_i \qquad where \quad a_{0i} = \sum_j a_{0j} \quad and \quad u_i = \sum_j u_j \tag{4.2}$$

In principle, this approach specifies value added as a function of various components of final demand, thus embracing the responsiveness or output to changes in aggregate demand conditions. This method implicitly asserts that value added is driven by aggregate demand. As expected, some parameters, a_{ij}, could be zero implying that some final users are omitted.

Musila and Rao (2002), Elliot *et al*. (1986) and Randakuwa *et al*. (1990) use this approach for varying sectoral outputs for the Kenyan and Sri Lankan economies respectively. On the other hand, El-Sheikh (1992) and Marzouk (1975) use a similar technique though with less detail in terms of disaggregation. In these studies output is classified into agricultural and urban value added. The latter is further classified into manufacturing, construction and other sectors. A Cobb-Douglas structure with land and agricultural credit as a proxy for other inputs is used for the former sector while the IO approach is adopted for the urban sectors. Both specifications and classifications have gained reasonable support empirically. A slightly different approach is used by Ghartey and Rao (1990) by estimating three equations for the production sector. These are aggregate output, agricultural output and manufacturing output. GDP responds well to changes in total employment and aggregate capital stock and is found to exhibit increasing returns to scale for both the restricted and unrestricted equations. On the other hand industrial output increased with GDP while agricultural output increased with industrial output.

4.3.2 The employment sector

The modelling of the employment sector in the context of developing countries is to a large extent driven by the assumption that labour supply is not a binding constraint and the level of demand in the economy determines that labour demand. The standard specification of labour demand in many models derives from the profit maximisation behaviour of the firm and relates employment to output and the wage rate. Other variants include foreign output, to capture the dependency of the employment sector on foreign influences, demand components, exports (See Musila 2002 and Elliot *et al*. 1986). The inclusion of the labour productivity as a dependent variable is not supported by empirical evidence in the KIPPRA Treasury Macroeconomic Model (KTMM) (See Geda *et al*. 2001). Basdevant (2000) models the level of employment such that it evolves in accordance with the marginal labour cost and is hence a proportion of potential output. Hall and Pauly (2000) also follow this approach. By the marginal labour cost property, an increase in potential output is a prerequisite for a sustained increase in employment. In turn, Ghartey and Rao (1990) use a different approach to modelling the employment sector. In this model, the employment sector features two equations of agricultural employment and the distribution of the labour force, which is described as the ratio of manufacturing employment to agricultural employment. Employment in the other sectors is treated as exogenous in this model. The study elicits the sensitivity of employment in the two sectors to changes in real wages and that a rise in real wages depletes agricultural employment.

A more comprehensive approach to modelling the labour market is adopted by Du Toit and Koekmoer (2003) for the economy of South Africa. The labour market in this study is explained by the supply and demand for labour and the wage adjustment equation. The merit of this approach is to capture market imperfections. The South African labour market is divided into the skilled and unskilled labour markets based on differences in the wage determination processes and differences in the demands for the these two types of labour. The model specifies and estimates demands for the two types of labour, their wage rates, supply of skilled labour and the total labour supply. The estimation procedure

entails the estimation of the cost function from which the production function and the demands for labour are derived within a framework of profit-maximisation behaviour. The study reveals that the labour market is highly influenced by government interventionist policy, union powers, the structure of the labour force, inappropriate production technologies and low productivity.

4.3.3 Modelling the level of economic activity in macroeconomic models

The central theme in modelling developing countries in the past has been the determination of the level of economic activity (Pandit 2000:7). This practice has been driven not only by the belief that the economy is demand driven but also by data limitations prevalent in most developing countries. A sizable amount of recent macroeconomic models use the small open economy IS-LM aggregate supply framework that was previously associated with and considered more suitable for developed economies (Musila 2002:296-297; Challen and Hagger 1983:3). Aggregate demand is determined endogenously by means of its components in many models. The Keynesian representation of aggregate demand dominates the modelling of the components of its components. Parsimonious forms of the consumption function that represent consumption as a function of disposable income are often adopted in developing countries for a number of reasons including underdeveloped markets, information asymmetries, liquidity constraints, measurement problems and other structural and institutional considerations. Among others, Khan (1987), Song (1981) and Musila (2002) find the simple Keynesian AIH, sometimes with habit persistence, to give reasonable approximations of consumption behaviour in developing countries[58] Elliot *et al*. (1986), Haque *et al*. (1990), Randakuwa *et al*. (1995), Musila (2002) and El-Sheikh (1992) adopt the life-cycle specification with real money balances as a proxy for wealth, and other variations to capture liquidity constraints and other factors as arguments. Though these specifications have performed reasonably well in these studies, country specific evidence provides reasonable approximations for varying economies.

[58] Few empirical works have found reliable or significant estimates of interest elasticity of consumption in developing countries. See for example, Rossi (1988), Giovannini (1983, 1985), Gonzales (1988), Ligeti (1989), Molho (1986), Oshikoya (1992) and Musila (2002).

In many cases, investment is modelled along the lines of the simple accelerator principle with some modifications. The Tobin Q specification is less popular in developing countries scenarios owing to lack of appropriate data and measurement problems. While many specifications of investment demand in developing countries centre around the accelerator principle, they nevertheless do not include either the rate of interest or the user cost of capital as explanatory variables. Again, this is blamed on lack of information (Haque *et al*. 1990:553), and the belief that the rate of interest does not play a major role in investment decisions in developing countries because of unorganised security markets (Watson and Ramlogan 1991)[59]. Among others, Marwah (1972), Haque *et al*. (1990), Randakuwa *et al*. (1995), Elliot *et al*. (1986), Geda *et al*. (2001) and Musila (2002) and Musila and Rao (2002) derive reasonable results from this approach used in the context of developing countries. Most of these studies confirm that the availability of funds is an important factor in investment decisions and indicate the dependence of investment decision on foreign capital goods. Mixed results are obtained regarding the relationship between government and private investments. In theory, an increase in government investment produces two opposing effects towards private investment. Increased public capital accumulation increases the national investment rate above the level that is chosen by rational agents and induces a crowding out effect on private investment. On the other hand an increase in public capital stock also operates to raise the return to private capital and hence a crowding in effect on private capital accumulation.[60]

Government expenditures on consumption and investment are often assumed to be rather unpredictable and determined exogenously in macroeconomic models. This treatment arises from the notion that government expenditure patterns are to a large extent influenced by political decisions, which in turn change erratically from one regime to another over short periods of time. There are a few models though that endogenises these variables. Randakuwa *et al*. (1995) estimates the consumptions of central and local

[59] See also Fry (1980, 1982), Molho (1986) and Oshikoya (1992).
[60] Among others, Sundararajan and Thakur (1980) and Aschauer (1989) provide empirical evidence that while both channels are operative, the public investment is highly likely to raise the profitability of private capital stocks and hence private investment.

governments, fixed and inventory investments of central government and other recurrent and capital expenditures of government behaviourally for the economy of Sri Lanka. Musila (2002) assumes government consumption expenditure to be fixed but specifies government fixed investment as a function of the level of output, imports of plant and machinery equipment and private fixed investment.[61] These studies find that government expenditures are influenced positively and significantly by a number of variables including the level of economic activity, government revenue and real national wealth. Some degree of complementarity between government and private consumption and investment expenditures is also established (see also Karras 1994 and Amano and Wirjanto 1994).

A common feature among developing countries is a mismatch between aggregate demand and aggregate supply. This aspect has been treated differently in the closure rules of macroeconomic models. The widely used approach is using the change in inventories as the equilibriating factor. According to Pandit (2000), this methodology is inappropriate as it may pose some theoretical and empirical problems. The argument is that while changes in stock cannot all be classified as unintended, it may prove difficult to isolate the unintended and intended changes. In addition, placing the burden of adjustment of the economy on changes in stock, a variable, which is usually of a small magnitude, may be inappropriate. An alternative closure rule in this case is to model and use capacity utilization as a balancing item. It is noteworthy however that capacity utilization is to a large extent supply driven and seldom influenced by demand factors. By implication, this leaves the level of economic activity to be determined on the supply side. Moreover, data on capacity utilisation is hardly available in developing countries.[62] Basdevant (2000) uses the latter approach to reconcile the discrepancy between supply and demand in the Russian economy. The output gap and the actual level of output are included as explanatory variables in some components of aggregate demand such as consumption, investment and exports. By these specifications, components of aggregate demand are made to depend not only on demand factors but also on supply factors. These variables

[61] See also Aghevli and Khan (1978) and Millar (1997).
[62] See Pandit (2000) for a detailed discussion of these methods.

are found to depend positively on potential output and negatively on actual output reflecting the notion that additional unused production capacity is required in order to enhance any of the demand components.

4.3.4 The external sector in macroeconomic models

Varied approaches have been used in empirical models of the external sector within macroeconomic models. Major differences usually stem from theoretical underpinnings, accounting systems and definition of variables depending on individual economies and availability of resources. The system of reporting the balance of payments usually differs across countries depending on a number of factors such as the structure of the economy and the importance of certain components in the economy. This results in variations in definitions of variables and calls for differences in the presentation of the external sector in models. Nevertheless, in principle, the external sector should indogenize trade flows, service flows, transfers and direct and portfolio capital flows (Pauly 2000) and highlight the adjustment process. According to Pandit (2000) the presentation of the external sector should reveal how the disquilibrium in the external sector impacts on the economy. This requires the incorporation of both demand and supply functions of trade flows. Many models of developing economies portray the small country assumption in the specification of the external sector. Because of this assumption, only demand conditions are modelled and supply conditions are disregarded. Other important considerations in modelling the external sector include the exchange rate regime, the openness of the economy, together with the degree of capital mobility and other institutional arrangements such as the nature of bilateral and multilateral trade arrangements. Some presentations of the external sector in models of developing countries are discussed below.

A widely used benchmark for empirically analysing the import and export demands in developing countries is given by Khan (1974), following from Magee (1969), with particular emphasis on price elasticities and the role of quantitative trade restrictions. Exports demand is specified traditionally as a function of the relative price of exports and

world income. In turn, demand for imports is expressed as a function of the relative price of imports and national income.[63]

In many models, imports and exports are disaggregated to highlight the importance of different sectors and commodities in international trade. The methods and degree of disaggregation follows the importance and role of categories of commodities in international trade and total economic activity. The degree of disaggregation is however dictated to a large extent by data availability in developing countries in particular. Lack of data, and its poor quality in cases where it is available, makes it difficult for researchers to afford disaggregation. Examples in which trade flows have been disaggregated are exports of tea and coffee in the economic models of Kenya developed by Elliot *et al*. (1986) and Musila and Rao (2002). Exports of tea, rubber, coconut products and services are also isolated from the rest of exports in Randakuwa *et al*. (1995). Musila (2002) uses a similar approach for exports of tobacco and tea in a model for the Malawian economy. In contrast, imports are classified into imports of intermediate and capital goods and imports of services, similar to the classification in Nordas and Angelsen (1998) for the Tanzanian economy. In economies where mineral products and oil products, for example play an important role in international trade, it makes sense to model them separately as these products usually represent the bulk of trade with the rest of the world and hence their isolation permits the analysis of their individual impacts on the respective economies. This approach has been followed, by among others, Soludo (1995) for exports of oil in the economy of Nigeria, Ghartey and Rao (1990) for exports of cocoa and gold in the economy of Ghana, Elliot *et al*. (1986) for petroleum and non-petroleum imports in total economic activity of Kenya and Beenstock (1995) in a model for oil importing developing countries.

The standard specifications of imports, with domestic economic activity and the relative price of imports, and exports with foreign demand and the relative price of exports as arguments, notwithstanding disaggregation issues, seem to be standard for developing countries in general, with mixed outcomes in each specific case. According to Pauly

[63] See also Krueger (1997).

(2000:11), tariff rates may be included as explanatory variables in the exports and imports demand function. The inclusion of an indicator for domestic supply constraints may prove appropriate in the exports demand function. Accordingly, Basdevant (2000) uses the output gap successfully for this purpose. While prices and income elasticities are important in the determination of the trade balance in other countries,[64] they tend to have negligible effects in other countries.[65]

Many macro economic models are confined to the use of aggregate imports and exports values. The KTMM for Kenya follows this aggregate approach and in addition, specifies exports from the supply side, reflective of the small country assumption.[66] On the other hand, in specifying a macroeconomic model for developing countries, Haque *et al*. (1990) relates real imports to the real exchange rate and real domestic output. A one period own lag is made to account for partial adjustment behaviour while the lagged reserve import ratio is used to capture the effect of the lack of foreign exchange on imports demand.

While transfers are in many cases treated as exogenous to the model, in some cases and when data permits, service flows are modelled separately from trade flows. These are often and best disaggregated into factor payments and non-factor payment with the former modelled as a function of the stock of total net foreign assets and the foreign interest rate, and the latter as a function of the volume of trade and some appropriated services price index (Pauly 2000:11).

4.3.4.1 Modelling capital flows and the degree of capital mobility

Modelling direct and portfolio capital flows within the context of a macroeconomic model has been an extremely challenging exercise in developing countries in particular. Because of the history of wide spread institution of capital controls in many developing countries, many models have tended to assume net capital flows are exogenous. Elliot *et*

[64] See Musila (2002), Elliot *et al*. (1986) and Randakuwa *et al*. (1995) for example.
[65] See Ghartey and Rao (1990).
[66] See Geda *et al*. (2001).

al. (1986), Musila (2002) and Randakuwa *et al*. (1995) follow this route. On the other hand, Beenstock (1995) adopts a stock adjustment theory in which capital inflows vary with economic growth, world interest rates and country risk. In addition to differentials between domestic and foreign interest rates and expected rate of change of the exchange rate, domestic tax conditions and the dynamics of the economy are often considered as influencing foreign capital flows (Pauly 2000).[67]

In pursuit of a representative structure, one of the factors that should be captured is the degree of capital mobility. The degree of capital mobility in developing countries is modelled and tested by way of the interest parity condition in Haque *et al*. (1990). An intermediary position is adopted by modelling interest rates as a linear combination of two polar case conditions under perfect mobility.[68] Nordas and Angelsen (1998) also adopt a similar approach with the assumption of an intermediate degree of capital mobility for the Tanzanian economy while Geda *et al*. (2001) assume nearly perfect capital mobility for the Kenya economy.

4.3.4.2 The exchange rate

Few developing countries' macroeconomic models tend to explicitly model the exchange rate endogenously. This follows from the historically controlled regimes previously prevalent in many developing countries. Examples of these are Musila (2002), Elliot *et al*. (1986) and Ghartey and Rao (1990). On the other hand,the modelling of exchange rate movements has posed major challenges to researchers over the years with developments ranging from the extent to which economic variables explain exchange rate movements to shifting the focus on the time series properties of exchange rate returns and lately the microstructure approaches that stress the institutional aspects and behaviour of market participants (See for example, Frankel and Froot (1986; 1988), De Grauwe and Dewachter (1993), De Grauwe *et. al.* (1993), De Jong (1991; 1997), Devereux (1997) and Aron *et. al.* (1997). The modelling of the exchange rate in the KIPPRA-Treasury model

[67] See also Agenor (1998), Bayoumi and Gagnon (1996) and Fedderke and Liu (2002).
[68] See also Edwards and Khan (1985).

for the economy of Kenya follows the uncovered interest parity condition of Dornbusch (1976), with the possibility of overshooting (Geda *et al*. 2001). The outcome of this approach is that the changes in the exchange rate are induced by changes in foreign and domestic price and interest rate differentials. With the open arbitrage approach Basdevant (2000) shows that changes in the exchange rate are explained by expectations of the exchange rate and the interest rate differential in the Russian economy. Brink and Koekemoer (2000) capture the determination of the exchange rate of the Rand within the framework of the sticky-price, Dornbusch-type monetary model. The subsequent outcome of this attempt is that the Rand/Dollar exchange rate is cointegrated with relative real output, relative money supply and the inflation differential.

The modelling of the external sector is in many cases closed by a series of identities that describe the major balances in the balance of payments. These often differ slightly, depending on the method used for recording and compiling international transactions in the balance of payments in individual economies.

4.3.5 The government sector

The econometric modelling of the government sector usually varies across countries to reflect institutional differences. The basic structure should however reflect the way in which government budgetary operations are interlinked with the rest of the economy. A general principle of capturing as comprehensively as possible the available policy instruments is recommended by Pauly (2000:8). Crucial elements that need to be captured include the expenditure patterns of government, the components and structure of taxation activities and the budget balance or government budget constraint.

Expenditure activities of government are often treated as exogenous policy instruments. In cases where it is considered appropriate to endogenize these variables, great care is often recommended in treating the reaction functions, as they tend to exhibit high volatility over time. Different classifications can also be applied where disaggregation is deemed appropriate, depending on the structure of the model and of the economy. This

could be according to smaller units or larger units such as investment and consumption expenditures. In a framework for a macroeconomic model for developing countries, Haque *et al*. (1990) presents a dynamic specification that describes the behaviour of the public sector through the government budget constraint. It is assumed in this model that the public sector finances its operations by acquiring assets from the external markets and the domestic markets. On the other hand government revenues comes from tax receipts and interest on foreign asset holdings. Government expenditure components include expenditures of domestic consumption goods and interest payments on domestic debt. A combination of these components yields the government budget constraint defined as the sum of the government saving and interest receipts from holding foreign assets less interest payments on domestic government debt.

Taxes are often treated as endogenous at either an aggregate or individual level. A challenging aspect in the estimation of the tax equations is the determination of the appropriate tax base for each tax aggregate. In many cases these are only approximations. Pauly (2000:9) points out that it is necessary to approximate taxable bases for income taxes while value added bases are adequate for value added tax revenues.

Three different approaches of modelling tax revenues in particular are popular in theory. The first and simplest approach involves specifying only one dependent variable, which represents the tax base of a particular tax receipt. The tax receipt is determined by multiplying the base with the rate such that

$$T = \tau B \tag{4.3}$$

where T is the amount of tax receipts, τ is the tax rate and B represents the appropriate base. Although this is a simpler way of determining tax receipts, determining the correct tax rate often poses a problem. According to Smal (1995:1), the identity can be rendered valid only when the exact tax base is known, the statutory tax rate is available and there is a full tax recovery rate. Pauly and Hall (2001) highlight the problem of obtaining an explicit tax rate especially in developing countries. Although this obstacle can be

overcome by calculating the implied tax rate as the ratio of the revenue to the base Smal (1995) notes that the implied effective tax rate will now contain some discrepancy between the utilised base and the true tax base.

The second method involves specifying each particular tax receipt in terms of one or more independent variable(s) that are highly correlated with it. This takes the form of an equation

$$T_i = f(A_1,...A_Z) \tag{4.4}$$

where T_i is a specific tax receipt and $A_1,...,A_Z$ represents a vector of explanatory variables.

The third approach embraces the complexities of the tax structure. This means that the tax laws and specifications to be incorporated in the modelling of taxes (Smal 1995:1). Pauly and Hall (2001)[69] point out that simple time series models in the form of transfer functions can be used to capture such dynamics of implicit rates. These may take the following general form

$$A(L)trate_i = f(dummies, trend) + \varepsilon \tag{4.5}$$

An equation of this form, sometimes with a time varying intercept in the original tax equation, may be useful in approximating improvements in tax compliance and/or tax collection. However, Smal (1995:1) notes that although this approach may have some practical long-term advantages, its forecasting performance is not expected to diverge by a large margin from models constructed on the basis of the other two methods.

As with other macroeconomic variables, the modelling of taxes in macroeconomic models has taken both the aggregative form and the estimation of the individual tax aggregates depending on individual country cases and the purposes for which the model

[69] See also Osoro (1993).

is built. The methods used by Musila (2002) to model the government sector of the economy of Malawi, Elliot *et al.* (1986) for the economy of Kenya, Ghartey and Rao (1990) for the economy of Ghana and Nordas and Angelsen (1998) for the economy of Tanzania have much in common. In all these models government expenditures and transfers are treated as exogenous while revenues are considered endogenous with taxes classified into direct and indirect taxes. Ghartey and Rao find both direct and indirect taxes to vary significantly with domestic output while Musila finds direct taxes to vary with national output while indirect taxes vary with the nominal export value and the import duty to be explained by the import bill and duty rates. In close resemblance, Elliot *et al*. relates direct taxes to the wage bill, given by the product of the average annual wage in the formal sector and the total wages of employees in that sector, import duties to the import bills and duty rates, while indirect taxes are explained by nominal consumption and nominal exports. Government saving is determined by total tax revenue and government expenditures. It is the size to the overall budget deficit or surplus in these models that affect the monetary base and hence provides a nexus between the government sector and the monetary sector.

Within the IS-LM-BP scenario, Nordas and Angelsen (1998) present the government sector of the Tanzanian economy in a budgetary framework. In this analysis, government expenditure comprises consumption and investment expenditures as well as interest payments on domestic and foreign debt. While the first two components are exogenously determined, domestic and foreign debts depend on the stock of debt accumulated and the domestic and international interest rates. In addition, the servicing of foreign debt is influenced by the exchange rate. The components of tax revenue include income tax, other taxes, the effective *ad valorem* tax on local goods, the effective *ad valorem* import tax on intermediate goods, the effective *ad valorem* import tax on consumer goods, and the tax on imports of investment goods. These taxes are in turn assumed to depend on their respective bases. The financing requirement of government is then given by the difference between tax revenues plus transfers and government expenditures. While it is assumed that the methods of financing the government deficit are independent of real

output, they however influence credit supply to the private sector given that total money supply is unaffected by government financing requirements.

While El-Sheikh (1992) does not model government expenditures explicitly, the modelling of taxes takes on the classification of indirect and direct taxes with further categorization of direct taxes according to those that assume proportional and progressive structures. As in other studies, the bases of the taxes are approximated by variants of relevant national aggregates. Following this procedure, various types of direct taxes are dependent on variables such as wages and salaries, commercial and industrial profits, interest in the form of movable property income and immovable property. The model also stochastically estimates import duties, excise and consumption duties, stamp duties, royalties and price differentials, as well as the contributions of revenues pertaining to pension and social insurances.

A much detailed and liberal approach to modelling the government sector is adopted by Randakuwa *et al*. (1995) whereby both government expenditures and taxes are estimated by behavioural equations and are disaggregated. Expenditures of government are split into consumptions of central and local governments, fixed and inventory investments of central government and recurrent and capital expenditures. The model estimates business turnover tax, selective tax, import tax, export tax and non-tax revenue in addition to the basic aggregates of indirect and direct taxes commonly adopted in other models. The model further estimates the changes in government domestic and external debts, where the former is related to the budget surplus and the latter to the trade and services balance in the balance of payments.

4.3.6 Modelling the monetary sector in macroeconomic models

Monetary sectors also tend to differ significantly across countries and in line with the structures of the financial systems and institutional characteristics. The modelling of the monetary sector depends largely on the monetary policy regime. According to Pauly

(2000) the modelling of the monetary sector should capture the roles of the monetary sector in the economy. These include:

- Modelling the transmission of conditions in the financial sector to other sectors by endogenising some measures of liquidity;
- Making an account of how money supply and other assets are affected by public sector deficits and developments in the balance of payments; and
- Reflecting the effects of decisions made by financial institutions on the monetary sector.

This comprehensive structure is adopted by De Wet *et al*. (1995) in estimating and evaluating an econometric model for monetary policy in South Africa. The model demonstrates the application of various market-oriented policy instruments in influencing the ability of the banking sector's extended credit and subsequently, money supply given the reserve requirements and the demand for money. The model adopts a relatively comprehensive way of modelling the cash reserve requirements, market oriented policy instruments that influence the cash reserves, the supply of credit and money and the discount policy, bank rate, demand for credit and money and the rate of interest.

It is notable however that, following the traditional approach and practice of the use of direct instruments of monetary policy in many developing countries, many models of developing countries tend to explicitly model the demand for money, and adopt the assumption that money supply is exogenous. This tradition is consistent with both the structures of monetary sectors, their stages of development, which embraces the services provided by these sectors, as well as the availability of potentially effective monetary policy instruments.[70] The tendency for models of developing countries to assume exogeneity of money supply is driven to a large extent by the existence of parallel markets and strong international influences, which makes it difficult for analysts to model such markets. The implicit assumption in such frameworks is that money supply adjusts to money demand. It is only in recent times with the advent of liberalization that the

[70] See for example, Chick (1993), Dow (1999), Eichengreen (1996) and Fry (1995).

move towards the use of indirect instruments of monetary control is recognized. Some examples of macroeconomic models with these features in developing countries are discussed below.

The modelling of the monetary sector in Musila (2002) follows directly from the approach used by Elliot *et al*. (1986).[71] In these empirical works, the monetary sector is modelled to explain the behaviour of monetary aggregates and loans and discounts to the private sector from deposit money banks. In both works loans to the private sector depends primarily on supply conditions. Thus credit to the private sector depends on monetary reserves, foreign liabilities and government deposits in both studies. Elliot *et al*. (1986) also include the deposit rate of interest and inflation as explanatory variables. An increase in inflation or a decrease in deposit rates is expected to raise the demand for discounts and loans as the real cost of borrowing from the bank is reduced (Elliot *et al*. 1986:5-6). This therefore implies that the level of discounts and loans are influenced by the sum of total reserves and currency, the inflation rate, the interest rate on saving deposits, foreign liabilities and the government deficit. Of these variables, the government budget deficit is determined in the government sector of the model and provides a link between that sector and the monetary sector. The monetary base comprises the net domestic assets and the net foreign assets of the banking system. In turn, changes in net domestic assets are positively related to the government budget position and negatively related to changes in net foreign assets. This relation also provides a link between the monetary sector and the government sector. Finally changes in net foreign assets depend on the balance of payments position and the foreign assets of the previous period in Kenyan pounds. It is this latter equation that provides a link between the monetary sector and the balance of payments sector.

Currency in the hands of the public, demand deposits and time and saving deposits are determined by real output alone in Elliot *et al*. (1986) while the latter two aggregates also depend on the nominal interest rate in Musila (2002). While Musila (2002) finds lack of

[71] The foundations of the monetary sectors in these models rest of the balance sheets of the Central bank and deposit money banks as expounded by Tobin (1969).

evidence of interest rates as a determinant of money demand for the economy of Malawi, the effect of the interest rate is not investigated in the Kenyan economy owing to the limited role that interest rates play in that economy (Elliot *et al.* 1986:5). In all instances the demand for money appears to be income elastic. The demand for time deposits is however more elastic than the demand for currency, as is the case in other countries.

In turn, Musila and Rao (2002) estimate two equations for money demand, the demand for narrow money and the demand for time and saving deposits being specified as functions of real GDP and nominal interest rates. Real GDP is found to be the most significant variable that explains changes in money balances in this case. This is in agreement with the results of the KTMM in which real GDP is found to the most significant variable in explaining changes in M2, followed by the CPI and the Treasury bill rate respectively. The KTMM also derives and estimates the equation for interest rate as an inverted money demand function, so that the rate of interest is expressed as a function of broad money M2, real output and the CPI.

As in Musila (2002), Randakuwa *et al*. (1995) estimate the demand for real narrow money and the demand for quasi money. The former aggregate depends on national income, the rate of inflation, and one period own lag. The latter aggregate is explained by real national income, the rate of interest, the rate of inflation and one period own lag. The rate of interest is found to have a positive influence on demand for quasi money while the rate of inflation has a negative effect on narrow money.

Haque *et al*. (1990) estimate a fairly standard form of money demand function that is expressed as a function of the nominal rate of interest and the level of income with a partial adjustment mechanism that captures lagged responses. The specification of the determination of the domestic nominal interest rate follows Edwards and Khan (1985). The nominal rate of interest is specified according to the uncovered interest parity condition as a function of the sum of the nominal interest rate prevailing abroad and the expected change in the value of the domestic currency (see also Pauly 2000:10). This specification is useful in testing for the degree of capital mobility in the economy.

A model for the Tanzanian economy developed by Nordas and Angelsen (1998) features a monetary sector that is constructed on the basis of the Keynesian IS-LM framework for purposes of analysing fiscal and monetary policy (Nordas and Angelsen 1998:5). It is assumed that monetary authorities control money supply and hence monetary policy is a powerful tool in controlling aggregate demand. The monetary sector is linked to the households, government and the rest of the world via interest on loans to and deposits of the former two agents and interest on foreign assets and borrowing and reserves for the latter. The money market recognises two types of assets, bonds and money. The demand for bonds is assumed to be a mirror image of the demand for money, which varies with income, and the rate of interest, the interest rate being an instrument for substitution between the two assets. Total money supply comprises the domestic component and the foreign component, where the domestic component is controlled by government and the central bank via monetary policy (Nordas and Angelsen 1998). A combination of the money supply and money demand relations yield the LM equation. Flows of financial assets are included in this model for accounting purposes. Private sector credit is obtained as a residual, assuming that government has priority in credit allocation. While money supply is exogenous, credit to government is determined from the government budget and net foreign assets are determined from the balance of payments.

As is evident from empirical models, the notion of equilibrium in which the rate of interest takes up the role of adjustment does not feature in developing countries. This is consistent with the modelling of both demand and supply of money so that the rate of interest is left to adjust the system. This is highly unlikely in the context of developing economies, given the stage of development of the money and financial markets which in turn dictates the range of monetary policy instruments available to policy makers. According to Judd and Scadding (1982:1013), one major argument for money supply exogeneity has been the use of the rate of interest as an instrument to control money supply. This means that the rate of interest has to be pegged for the authorities to adjust money supply to match whatever quantity of money the public demands at the prevailing rate of interest. Hence the assumption that money supply is adjusted to meet money

demand is considered consistent with structural conditions in these economies. When dealing with a small developing economy, it therefore seems necessary to explore the demand for money in more detail both from a theoretical and empirical perspective. Empirical evidence shows the extent of variability in demand for money functions in terms of specification, aggregation and estimation techniques over the years.[72] While the specification of the demand for money function has not undergone tremendous change over the years and across countries, estimation techniques have been at the forefront of major changes in the specification of money demand functions. Error correction mechanisms, in particular are used widely in later empirical works (see for example, Buscher and Frowen 1993; Aretis 1988 and Laidler 1999). However, it is evident that the level of income and the opportunity cost are key determinants of money demand across these differences.

4.3.7 Price and wage determination

Disequilibria between demand and supply in different markets exert pressures on prices in any market economy. The modelling of prices is one of the most important issues in macroeconomic modelling. This derives from the fact that price stability is one of the major themes on which macroeconomic policy is focused. The underlying principle in many macroeconomic models is that while adjustments to equilibrium are almost instantaneous in financial markets, the process of adjustment is much slower in goods and labour markets in general.

Interestingly, there is hardly consensus among empirical works on the determinants of inflation. On the theoretical front, the role of labour and asset markets in the determination of inflation is a central issue. A synthesis of the performance of the monetary model in the context of developing countries still raises concerns about the role of monetary policy as a stabilization tool. [73] The alternative view is that inflation in

[72] Some relevant empirical works in the context of developing countries include that of Adekunle (1968), Adam (1992), Pathak (1981), Darrat (1985), Domowitz and Elbadawi (1987), Coats and Kathkhate (1980) Judd and Scadding (1982) and Sriram (2001).

[73] Using similar frameworks, Saini (1982) and Tegene (1990) find conflicting results for groups of developing countries while Saini (1982) found that the monetarist model does not fit the experience of six

developing countries may be traced, to a large extent, to structural factors. These include the inelastic supply of foodstuffs resulting from structural constraints in the agricultural sectors. Domestic financial constraints also compel governments to deficit financing methods that trigger inflationary pressures. In addition, foreign exchange constraints cause a devaluation to accelerate domestic price pressures. It is further argued that the existence of price controls and variations in the velocity of money, which essentially destabilizes the money demand function, may invalidate the ability of the monetary model to explain changes in inflation.

While the simplest monetary model may not fully explain inflation under these circumstances, another alternative view is that a monetary theory of the balance of payment that incorporates traded and non-traded goods prices and exchange rate movements may be adequate in tracing the inflationary process. Empirical evidence of this view is however also mixed.[74]

The determination of prices in many macroeconomic models of developing countries almost invariably follows the assumption that consumer prices in particular are determined by demand conditions. While the asset markets feature prominently in the determination of prices with money supply widely used as a proxy for excess liquidity in the economy, the labour markets have not been accorded adequate attention in this regard in developing countries.

Asian countries, Tegene (1990) found that a similar framework explains the experience of six African countries. Money supply was found to exert a positive influence on inflation while growth of real income dampened inflation. The influence of world inflation was found to be evident in four out of six countries. These findings are in contrast to those of London (1989) in a larger sample of African countries in which the monetarist model is found inadequate in providing a full and consistent explanation of the inflationary process.

[74] While Romer (1993) finds a negative relationship between the degree of openness and inflation for a large sample of countries, a sample of a small group of mostly developed countries fails to provide evidence of any relationship between inflation and the degree of openness. In contrast, the findings of Aghevli and Sassanpour (1982) reveal that non-traded and traded goods take equal weights in the determination of domestic prices. Moreover, given a fixed exchange rate, monetary factors and the price of imports have a significant influence on the price of non-traded goods. See also Khan and Knight (1981, 1982), Goldman (1972), Spitaller (1978), Khan (1980), Montiel (1986), Aghevli and Khan (1978) and Bahmani-Oskooee (1991).

Musila (2002) makes use of a modified specification of the mark-up unit-cost approach following Nordhaus (1971) and Tavlas (1983) for the economy of Malawi. According to Nordhaus (1971) and Tavlas (1983), the long-run price in the economy is a function of import prices and wages. In this framework the optimal long-run price in an economy with a Cobb-Douglas type of production function with constant returns to scale is given as

$$p = ZQ^{1}W^{a_1}PM^{a_2} \tag{4.6}$$

Where p is the sales price per unit of output, Z is a scale term, Q is the index of Hicks-neutral technical change, W is the price of labour per unit of output, PM is the price of imported goods per unit of output and a_1 and a_2 are the shares of labour and capital respectively in total shares. An estimable form of this formulation is presented as

$$p = a_1\left(\frac{w}{q}\right) + a_2 PM + z \tag{4.7}$$

In this case lower cases represent relative rates of change and w and q are the respective wage and productivity components of unit labour costs, pm is the unit price of imported goods and z is the scale term, which represents the mark-up fraction and depends on the level of excess demand. By the homogeneity property, the weights of these variables should add up to unity and should reflect the degree of openness in the economy (Musila 2000; Pauly 2000). Using a modified version of the structure, Musila (2002) specifies both the GDP deflator and CPI as functions of the lagged wage bill per unit of output and the unit costs of imports. This approach is also applied by Elliot *et al*. (1986), in modelling prices in the Kenyan economy. By this approach, Elliot *et al*. (1986) specifies the CPI as a function of wages, labour productivity and the unit value index of merchandise imports. The output deflators of different sectors are estimated separately. The deflator for GDP in government services is estimated as a mark-up over wages while the deflators for GDP in industry and services industries are calculated as a mark-up over wages and import prices. The agricultural GDP deflator is calculated as a ratio of nominal

agricultural GDP and real agricultural GDP. Export and other implicit price deflators for components of national expenditures are determined by sectoral output prices and import prices while other deflators for GNP are derived from accounting definitions. Both empirical works fail to establish the role of demand in the determination of the CPI and GDP deflator. The wage bill per unit of output and unit costs of imports are found to have a positive influence on the CPI ad GDP deflator.

The GDP deflator and the CPI for domestic goods and services in Randakuwa *et al*. (1995) is determined by the average factor cost index and the one period own lag. The latter variable is representative of expectations. The CPI of imports depends on the CPI of imports of consumer goods and a one period own lag. On the other hand, the CPI of exports is determined by the prices of tea and coconut exports. In turn, the CPI is specified as a divisia index based on price indices of three categories of goods and services. While the export price index depends on the price indices of major traditional exports and non-traditional exports, the import price index depends on the price indices of consumer goods, intermediate goods and capital goods imports

Also following Nordhaus (1971) and the mark-up over cost approach, Musila and Rao (2002) determine the GDP deflator, the CPI and the export and import price indices within the framework of the Kenyan economy. Wages are however replaced with factor costs in the specification of the GDP deflator. The CPI is specified as a function of the weighted average of import prices, the GDP deflator and real money balances. These specifications are found to suit the Kenyan economy and perform well statistically.

The wage rate is often modelled to reflect conditions in the labour market. Pauly (2000) contends that while in the long run real wages are determined by productivity growth, short-run deviations from the real wage productivity linkage are likely to be generated as a result of excess demand or supplies in the labour market. In Musila (2002) the nominal wage rate is expressed as a function of the ratio of employment to population, and previous period CPI. The former variable is included to capture the tightness in the labour market while the latter variable captures the feedback effect of prices on nominal wages.

Elliot *et al*. (1986) estimates the nominal wage rate as determined by the level of unemployment and expected inflation.[75] The former is made to represent the cyclical component in line with the short-run Phillips curve, while the latter variable represents the role of inertia in the inflation process. Within this basic framework separate wage equations are estimated for the agricultural, government, industrial and service sectors. Both inflation and unemployment are found to be positive but significant only in the case of agricultural wages. The results reveal that wages in both government and non-government services are determined by lagged consumer price inflation while wages in industry depend on current period CPI inflation rate and productivity.

On the other hand, the modelling of export and import prices is made to reflect the fact that many developing countries are price takers in international markets. By this assumption, aggregate rather than disaggregated export and import price indices are often determined endogenously.[76] According to Pauly (2000), export prices are specified as functions of domestic and foreign prices with the relative weights reflecting the extent of price setting power of domestic producers on international markets. In Musila (2002), the world prices and the exchange rate play a major role in explaining import and export price indices. Musila and Rao (2002) determine export and import price indices as functions of world demand and changes in the exchange rate.

4.4 THE TREATMENT OF EXPECTATIONS IN MACROECONOMIC MODELS

One of the aspects in which there is lack of consensus in analytical macroeconomic models is the formation and incorporation of expectations. While expectational variables were not so common in traditional Keynesian models, they are of late used widely in recent models. Expectations are most common in variables that play a central role in modelling the monetary sector, capital flows, exchange rate determination, consumer durables, movements in money wages and prices such as the rate of interest, the exchange rate and inflation (Challen and Hagger 1983). Given that expectations are generally

[75] See also Spitaller (1978).
[76] See Randakuwa *et al*. (1995).

unobservable, models of expectations formation differ according to the assumptions made about the agents' information set. In turn, the behaviour of the model tends to depend critically on the assumptions made on how expectations are formed in determining which variables appear in the agents' information sets as they form their expectations (Pauly 2000).

Traditional models of expectations are adaptive in nature and assume that the only relevant information to form expectations is contained in lagged observations of the dependent variable. This assumption makes the implementation of expectations relatively easy. Given that expectations are unobservable, the implementation of the alternative forward-looking behaviour requires a different specification of the agents' information sets, which is linked to the expectations about variables exogenous to the models.

In principle, forward-looking and fully rational expectations are theoretically appealing. These types of expectations however seem inappropriate in a model designed for a developing economy (Pauly 2000). Information asymmetry is widely known as a problem common to most developing economies. Pauly (2000) contends that the structural modelling of expectations as a function of a subset of observable variables seems to be an appropriate alternative in such cases. To these, time-varying parameters may be used to add a flavour of learning types of expectations to the model. The latter alternative is used by Basdevant (2000) in a model for the Russian economy. The use of time-varying parameters in this case captures structural change, while it also introduces learning expectations to the model. In another attempt, Koekemoer (2001) successfully applies a variant of the learning model of expectations in testing the hypothesis that South African consumers are forward-looking with respect to prices when making consumption expenditure decisions. The study specifies a simple model of expectations formation in which the coefficient vector of the expectations rule is treated as an unobservable component. The model assumes that the learning pattern of consumers follows a Kalman filter-based (boundedly rational learning) process. By this process, agents update their expectations conditional on past forecasting errors.

In contrast to the common belief that forward-looking expectations are not suitable for developing countries, Haque *et al*. (1990) assumes that forward-looking agents form expectations rationally in the construction of the macroeconomic model for developing countries.

4.5 LOW QUALITY AND LIMITED DATA SETS AND STRUCTURAL CHANGES

The problems of discontinuities in data and structural changes often pose a major question of the appropriate methodology to be adopted. As noted in Basedvant (2000), Basdevant and Hall (2000), Hall (1993), Hall and O'Sullivan (1994), Greenslade and Hall (1996) and Hall and Pauly (2000), macroeconometric modelling can still be a useful tool in the presence of structural changes as long as the modelling exercise takes explicit account of as much information as possible about the change that has taken place. Among the models discussed in this review, this approach is implemented in Basdevant (2000) in the model for the Russian economy. Drawing from Clements and Hendry (1996a,b; 1998), who demonstrate that consistent adjustments in the constant term may compensate for a wide range of structural changes, time-varying constants estimated with the Kalman filter are introduced accordingly in the behavioural equations of the model to take account of the structural change. The ECM structure adopted in Basdevant (2000) takes the following form.

$$\Delta X_t = \sum_{i=1}^{k} (\alpha_{0i} \Delta X_{t-i} + \alpha_{1i} \Delta Y_{t-i}) - \gamma (X_{t-1} - X^*_{t-1} - \varepsilon_t) + \upsilon_t \qquad (4.8)$$

$$\varepsilon_t = \varepsilon_{t-1} + \delta_t \qquad (4.9)$$

Where ε_t is modelled as a random walk and υ_t and δ_t are white noise error terms. The Kalman filter is used in this structure to permit the computation of data for ε_t, which adjusts to structural change while minimising the variances of υ_t and δ_t.

4.6 CONCLUSION

4.6.1 Overview of general literature

The literature reviewed in this section has been limited to empirical models of developing economies in particular. While the exercise of macroeconometric modelling in developing countries can still be considered to be at a rudimentary stage, a number of advancements in macroeconomic modelling in general and in the context of developing economies alike are evident from the inspection and comparison of the earlier models to recent models. While there is adequate consensus in the structure of the models, this can seldom be testified to in theoretical aspects. Predominantly Keynesian structures in the modelling of the expenditure and monetary sectors are a common feature in many macroeconomic models of developing countries. This in turn, is driven, to a large extent, by the structural organisation in the economies under observation. One of the salient observations, however, is the move from the basic assumption of an exogenous supply sector prevalent in many of the early macroeconomic models to the explicit modelling of the supply sector with the assumption that while the economies are supply constrained and aggregate demand is the major driving force in the economies, there is ample room to accommodate the supply sector as it also plays a major role in the determination of some macroeconomic variables and can be potentially targeted for policy purposes.

Another outstanding and common feature in many macroeconomic models is the failure to explain the process of adjustment from positions of disequilibria in the external sector. While the demand side of the flows in the external sector explored fairly well in many models with focus on the elasticities, the supply side of the flows is to a large extent ignored. While this emanates from the fairly reasonable assumption of small countries and the existence of institutional arrangements, it also disregards the important question of the magnitudes of the disequilibria in the external sector and how they are transmitted into the domestic economy. This deficiency is closely related to the specification of the closure rules, which represents one of the major deviation points in macroeconomic models. The condition that markets do not always clear, and in particular that aggregate demand is not equal to aggregate supply, is presented and explained in varied ways

ranging from shifting the discrepancy to the change in inventories to capacity utilization. The former method is widely used, while the latter is scarcely utilised. While shifting the difference to change in inventories is the easiest way of handling this discrepancy and conforms to the demand-driven economy assumption, the use of capacity utilisation has the attractive and desirable advantage of shifting the burden on both supply and demand factors, as is the lately hypothesised basic scenario. It is also noteworthy that the route of change in inventories is criticised on the basis of placing too much burden on a variable that is often small in magnitude (see Pandit 2000).

The review also established that the government sector is modelled in a fairly limited way in many models with debt variables and their linkage to the macro economy, in particular, not accounted for specifically. This presents one of the interesting areas given that the avoidance of the twin government budget and debt crises is often at the centre stage in the debates on appropriate macroeconomic policies of developing countries.

While money demand, at different disaggregation levels, is given special and adequate attention in models of developing countries, this cannot be attested to with regard to money supply and the rates of interest. Again this follows from structural and theoretical considerations. The specification of money demand follows the traditional route of some measure of a scale variable and opportunity cost variable. In line with structural conditions and the conduct of monetary policy, especially in developing countries, money supply is largely assumed exogenous and as a policy variable. Few models tend to stochastically estimate other aggregates of the monetary sector such as credit to the private sector and the change in net foreign assets. In many cases, the former variable is determined from the supply side in line with the belief that private sector credit in developing countries is determined by supply conditions rather than demand conditions. Again, few models estimate the rates of interest stochastically. This practice stems from the consideration that the rate of interest plays a very limited role in these economies.

In line with the complex structures of the economies and the challenges involved, the determination of exchange rates is tackled in only of a few of the models reviewed here.

This practice is attributed to the fact that while modelling the exchange rate in itself is a challenging task, the exercise becomes more complex in countries commonly known for parallel markets. The rarity of the explicit modelling of capital mobility in these models can also be partly blamed on these factors.

A major shift in the estimation techniques is evident in the models from the traditional econometric methods of simple OLS, 2SLS and ILS to the use of cointegration and error correction models. The latest models are in favour of the latter methods as they permit the incorporation of both the long-run and short-run dynamic adjustments in the model, a feature that many of the former estimation techniques lacked. One of the major developments related to the estimation techniques involves the incorporation of structural changes in the economy by the use of time varying intercepts within the context of error correction models. These are estimated by the use of the Kalman filter and address an additional aspect of incorporating expectations in the models. Many models still fail to introduce expectations. Some early models introduced expectations formed in an adaptive fashion, and others introduced rationally formed expectations, both with heavy criticism. Though scarcely used in models discussed in this review, the learning types of expectations have become popular in the context of developing countries with the Kalman filter being used to tackle them.

It is noteworthy that data limitations in developing countries are at the top among the factors that drive the design of macroeconomic models in these economies. Aspects such as the level of disaggregation, which sectors to models and to what extent, the specifications of the interrelationships and ultimately the purposes for which the models can be used are to a large extent dictated by the availability and quality of the data set. This limitation has affected modelling exercises in many ways. In many cases inconsistent data sets prohibit the designs of the models to approximate and reflect the structures of the economies for which they are designed, as some sectors have to be excluded. In addition, the conformity of the estimates to theoretical predictions and forecasting performances of the models are also affected by this restriction, hence the

parsimonious and simplistic nature of most models of developing countries. An example of this is the homogeneity condition in the price equations.

4.6.2 Lesotho macroeconomic models

A look at the history and status of macroeconomic modelling in Lesotho shows that macroeconometric modelling in Lesotho is at an extremely rudimentary stage. All the available and known models are hardly operational at this stage because of lack of proper updating and partly because of lack of capacity in the field of macroeconomic modelling. In fact, the CBL currently uses a financial programming tool designed in conjunction with the IMF to produce forecasts. Thus, the need for a consistent macroeconomic framework that captures the structural characteristics of the economy, while it also keeps up with developments in the theoretical sphere and subject to regular updating, is evident. These deficiencies form the basis on which the construction of a macroeconometric model in this study is premised.